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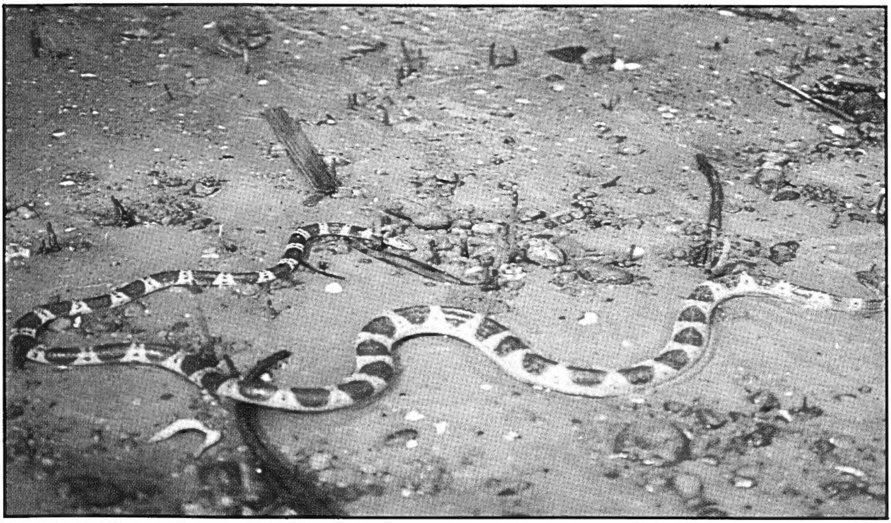
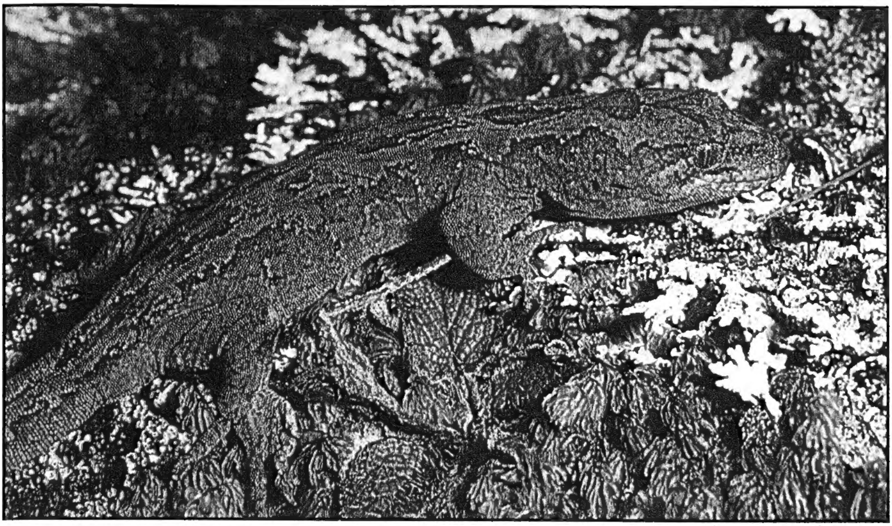
HERPETOFAUNA

Volume 27 Number 2 December1997



A sea snake *Hydrophis elegans* from Weipa. See paper on page 2. (Photo: Rob Porter).



The Takitimu gecko (*Hoplodactylus* sp.) a newly discovered species from Southland New Zealand. See paper on page 49. (Photo: Tony Whitaker)

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HERPETOLOGICAL NOTES

ISSN 0725-1424 Printed by Acrobat Print, Sydney (02) 9417 3820

RECORDS OF MARINE SNAKE SPECIES FROM THE HEY-EMBLEY AND MISSION RIVERS, FAR NORTH QUEENSLAND

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ABSTRACT

A total of fourteen species of sea snake (Family Hydrophiidae) and one species of file snake (Family Acrochordidae) were recorded during two separate visits to Weipa, far North Queensland. Details of these captures and other observations are provided.

INTRODUCTION

As part of an on-going commitment to supply the Commonwealth Serum Laboratories (CSL) with venom for the production of anti-venom, the Australian Reptile Park agreed to assist CSL by collecting specimens of the beaked sea snake (*Enhydrina schistosa*) with the aim of long-term captive maintenance and regular venom extraction. This species appears to be uncommon in Australian waters (Cogger 1975; Ehmann 1992), probably an indication that this is the southern limit of its natural range, although the species has been recorded from Ayr on the eastern Queensland coast, with isolated records from as far south as Morton Bay (Covacevich and Couper 1991). Weipa was indicated as one locality where the species could be located (Coggers pers. comm.) and two collecting trips were made on 29th March to 4th April 1996 and from 11th to 14th May 1996. Data were recorded from four collecting nights during the first trip, three from the second. One author (RP) participated in both trips, the others only in one trip.

Weipa is situated at the convergence of the Hey-Embley and Mission River systems on the far north-western coast of Cape York Peninsula (latitude 12.5°S). The two river systems drain into Albatross Bay and, ultimately, the eastern Gulf of Carpentaria. In the lower estuarine reaches the river banks are mostly lined with mangrove swamps with occasional sand bars and beaches. Full details of climatic conditions can be found in Cameron and Cogger (1992).

During the course of these two trips a large number of marine snake species and specimens were observed. Brief records were maintained of the approximate abundance, age and general observations of the various species. These data are recorded here.

METHODS

All snakes were located and captured at night while searching by boat. The search began at dusk and continued for approximately five hours per night, covering various stretches of the estuary. Small boats around 3.5-4.5m in size were used, powered by 25-40 hp outboard motors. A cruising speed of 5-10 knots was maintained by the driver whilst a 'spotter', positioned at the front of the boat, searched with a 150 watt 12 volt hand held spotlight in a 120-140° arc centred directly forward of the bow for a distance of 15-20m. On spotting a snake, the driver was alerted, changed direction and picked up the snake in his own spotlight beam. The boat was then accelerated and steered slightly to the left of the reptile. This allowed the spotter to exchange his spotlight for a dip net and, hopefully, capture the snake before it could dive beneath the surface.

Once captured, the snake was identified and immediately released, excepting specimens of *Enhydrina schistosa* or species that proved difficult to identify. These animals were transferred to large open weave holding bags which were then hung in large 70 litre plastic containing 15cm of sea water, ensuring the snakes could easily emerge to breathe. Specimens of *E. schistosa* were held pending transportation to

the Australian Reptile Park, while other species were released once identified. With practice, it became possible to identify common species that did not attempt to dive from the surface without netting. Due to time constraints detailed information could not be recorded, so approximate data was compiled at the end of each collecting night.

Seven search nights were spent in the Hey-Embley estuary and one in the Mission River estuary. Search areas are indicated in Figure 1. A brief excursion into Albatross Bay through the Jackson Channel proved fruitless with only one sea snake located after some 30 minutes searching.

All specimens were identified using Cogger (1992). Juvenile snakes were differentiated from adults on gross observable size differences, along with the ontogenetic colour changes of certain species.

RESULTS

Fourteen species of sea snakes (Family Hydrophiidae) and one file snake species (Family Acrochordidae) were recorded during the two trips (Table 1). As many as 100 specimens of snake were observed in a single night, i.e. of ten hours boat search time (5 hours per boat). *Lapemis hardwickii* was by far the most abundant species encountered, followed by *Acrochordus granulatus* and *Aipysurus eydouxii* (Table 1). Six of the remaining twelve species recorded, (*Aipysurus duboisii, Disteria major, Hydrelaps darwiniensis, Hydrophis sp., H. inornatus* and *H.ornatus*) were represented by a single specimen: in total 13 species of sea snake and one file snake were located in the main Hey-Embley River system search area of approximately 6.5 square km, as described above. One species, *Hydrelaps darwiniensis*, was located only in the Mission River search area.

Using published data for size at maturity (Shine 1991; Cogger 1992; Ehmann 1992), the percentage occurence of juvenile or sub-adult snakes of each species (Table 1) indicates that a high proportion of the population of five species (*Aipysurus eydouxii, Astrotia stokesii, Disteria kingii, Lapemis hardwickii* and *Hydrophis pacificus*) in these estuaries comprise immature specimens. Conversely, three species (*Acalyptophis peronii, Acrochordus granulatus* and *Hydrophis elegans*) were predominantly represented by adult specimens. *Enhydrina schistosa* comprised approximately equal numbers of adults and juveniles.

The two trips were timed to permit sampling during both a full and weak moon. During each trip there was a little variation in weather conditions, with winds at times reaching around 10 knots, plus occasional squalls. Any variability that did occur appeared to have little, if any, effect upon the overall abundance of sea snakes. Indeed, snakes were still abundant in this area during June 1996 when winds of 20-30 knots were encountered (W. Forrest pers. comm.)

During the last two nights of the second trip, a depth sounder was used to provide extra environmental information. Water temperatures were fairly stable at around 28°C±1.5°C. Depths were recorded at the capture point of seven specimens of *Enhydrina schistosa*, three were captured in 8-8.5m of water, the remaining four, all juveniles, in six metres.

Specimens of *Acrochordus granulatus* were particularly common along the edge of sea grass beds on the southern side of the estuary from Leithen Creek to Leithen Point. Some 20 specimens were observed in this area over a three hour period. No Hydrophiidae species were observed in this area. This species was also frequently encountered in open water throughout the search areas of the two river systems. Several copulating pairs and one trio of two males and a single female were observed, one pair during the first trip and at least five pairs and the trio during the second trip. Pairs were often aligned vertically, with the intertwined tails at the surface. Males were substantially smaller in length than females and there also appeared to be evidence of sexual dimorphism in coloration, males exhibiting a more orange hue compared to the grey-brown

females.

The only other evidence of potential courtship/copulation was an instance of two specimens of *E. schistosa* coiled together when captured on 12th May. The snakes were not copulating at capture but were found coupled in a holding container on the 14th May.

When first observed, most snakes were either swimming slowly or inactive on the surface. In many cases, approach by boat did not affect the snake until the vessel's wake disturbed its movements, when it would usually, although not always, attempt to dive. Some specimens, particularly large *L. hardwickii*, were very sensitive to disturbance, diving after a characteristic lifting of the head above the surface for a breath immediately on being illuminated.

Several species (*A. eydouxii, L. hardwickii* and *E. schistosa*) were often located coiled up in a ball on the surface. This behaviour was particularly common in *Aipysurus eydouxii*, which could be identified from a distance by this character. All four specimens of *E. schistosa* observed in this position were juveniles and all were located within 100m of the Lorim Point export wharf. Despite regular searches, these were the only specimens captured in this area and were all located late at night between 2320-2350 hours, on two separate nights.

DISCUSSION

There are numerous references on the occurrence of sea snakes in northern Australian waters, particularly the Gulf of Carpentaria (Heatwole 1975; Redfield *et al* 1978; Wassenberg *et al* 1994), mostly in reference to incidental catches in commercial fishing nets and its possible effect on sea snake populations. Abundance of the various species is provided in these studies, usually as a catch rate of snakes per trawl hour. It is difficult to compare these with the data in this study due to the differences in capture techniques. It might appear that the abundance in these estuaries is higher than in previous studies (Redfield *et al* 1978; Wassenberg *et al* 1994) but the two techniques may be incomparable as the trawl is a random sample over a given area with snakes mostly captured beneath the surface, as opposed to active surface searching.

The overall species diversity in the river system is at least comparable to that in the Gulf. Shuntov (1971) reported a total of 16 species collected during trawling activity over a wide area from Western Australia to the Gulf of Carpentaria. Two other studies (Redfield *et al* 1978; Wassenberg *et al* 1994) recorded 13 and 14 species of sea snake respectively in the Gulf. Cameron and Cogger (1992) list eight species from the Weipa region and only recorded three species during limited surveys. The total diversity of 15 species in this study appears to be extremely high, especially when the small size of the collection area is taken into account. Resource partitioning in sea snake assemblages is usually based on trophic and spatial requirements (Heatwole 1987). It may be a worthwhile exercise to examine the partitioning of such an estuarine habitat where fifteen species were recorded in a small area. It is possible that resource overlap between members of this assemblage is substantial but that, because the habitat may be used as a breeding ground or nursery, seasonal fluctuations in the abundance of individual species may reduce the effects of such competitive interactions. It may also reflect some seasonal variation in suitable prey availability.

The relative abundance of the species located in this study is somewhat similar to those reported by Redfield *et al* (1978) and Wassenberg *et al* (1994), in that *L. hardwickii* dominated the sample. Their figures of 61% and 53% of the catch respectively is higher than the 38% in this study, although if *Acrochordus* is removed from the total for the present study (this species was not included in the other studies) the figure for this species then becomes a more comparable 49%. Species which comprised relatively large proportions of other Gulf of Carpentaria studies, i.e. *Hydrophis elegans* (Heatwole 1975; Wassenberg *et al* 1994) and *H. ornatus* (Shuntov 1971), only amounted to 4% and <1% respectively in the current study. Observed variation in the composition of catch-

es according to latitude, depth and season (Wassenberg *et al* 1994) may explain some of these differences.

Two species recorded in this study represent range extension or confirmations of extensions. Neither *Hydrelaps darwiniensis* nor *Hydrophis inornatus* are shown to occur in the Weipa region by two recent publications (Cogger 1992; Ehmann 1992). However, Cameron and Cogger (1992) refer to one specimen of *H. darwiniensis* from the Mission River and Heatwole (1975) lists one specimen of *H. inornatus* from the southern Gulf of Carpentaria.

The records for two species in the current study need some verification. Firstly, the 8 specimens identified as *H. pacificus* are of interest in that only a single specimen of this species has been positively identified in Australian waters before this study (H. Coggers pers. comm.). It is possible that these snakes may have been incorrectly identified and, unfortunately, permits were not available to collect voucher specimens. What is certain is that these 8 specimens still represent a distinct species, thus maintaining the overall diversity in the study.

Secondly, identification of the specimen listed as *H. coggeri* in Table 1 cannot be confirmed. The snake was held overnight for identification purposes but was found to be dead the following morning. At that stage is was tentatively identified as *H. gracilis* mainly because of its prominently keeled scales. As the snake was dead and could not be identified with any certainty it was held and deposited at the Central Coast campus, University of Newcastle as a voucher specimen. Subsequent examination ruled out *H. gracilis* due to the absence of divided posterior ventral scales, and a tentative identification was made as *H. coggeri*, however further work is required to confirm this (H. Cogger pers. comm.).

The high representation of juvenile snakes of some species suggest such estuarine environments may act as breeding grounds and/or nurseries. Further evidence for this is the lack of juveniles collected in adjacent Gulf trawls during April-August (Wassenberg *et al* 1994) and the high proportion of juveniles observed in other estuarine studies (Voris *et al* 1983; Voris 1985). The low occurrence of juveniles of other species in the present study may be an indication of differing reproductive cycles.

There appear to be few references to the snake fauna of estuaries in Australian waters, e.g. Cameron and Cogger (1992). Overseas, detailed studies of an estuarine population of *E. schistosa* have been documented in the Muar River estuary, Malaysia (Voris *et al* 1978; Voris and Jayne 1979; Voris *et al* 1983; Voris 1985). Using a mark-recapture technique, the population size in that study was estimated at around 2000 snakes, approximately equally divided between adults and juveniles, though no indication was given as to the size of the study site except that the nets were set approximately 1.5km apart.

The coiling behaviour noted in the present study is observed fairly regularly in some species, both by day, when it may be a means of thermoregulation, and at night, when it may simply be a resting or sleeping position (H. Cogger pers. comm.). Most specimens in this postion when approached appeared to be lethargic and slow to respond. It may also be advantageous in terms of energy conservation to rest in such a position rather than having the body extended. Thermoregulation may also be an important benefit at night, if the upper layer of water retained some of the day's heat until mixing occurs.

ACKNOWLEDGEMENTS

The authors gratefully acknowledge the generous help and assistance provided by Comalco, Weipa, who provided accomodation, transport, staff and other materials, and without whom this work would not have been possible. Particular thanks go to the following Comalco staff and Weipa residents; Paul Warren, David Khalu, Nigel Peace, Nikki Woods, Wayne Forrest, Bruce Bates, Kevin Parry, Kirstin McMillan, Sue Gould and the staff of the single persons quarters, Weipa. Invaluable help and advice was also provided by Hal Cogger and

Ken Zimmerman, Central Coast campus, University of Newcastle.

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Figure 1. Map of the collection area.

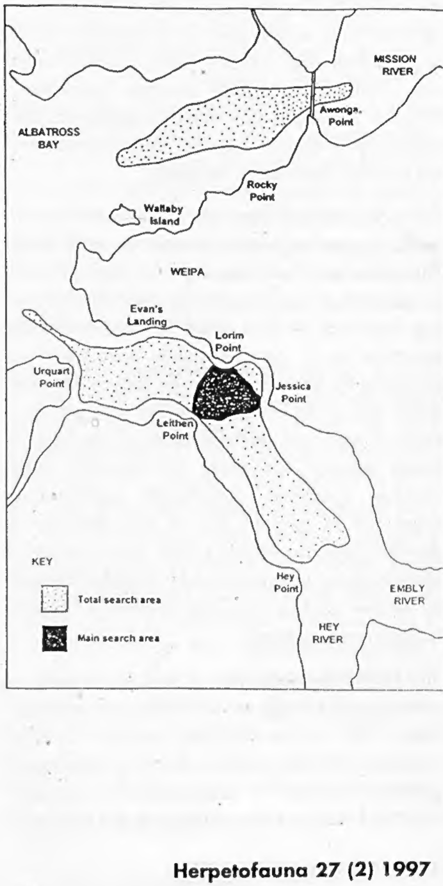
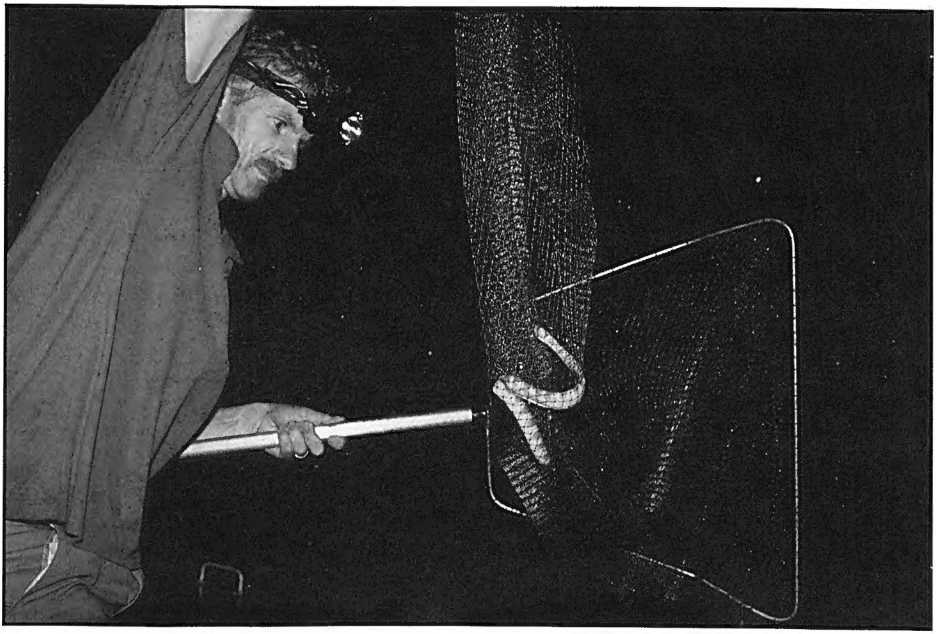


Table 1. Marine snake species and their relative abundance in the Hey-Embley and Mission River systems.

Species	No. Recorded	% of Total	Rate*	% Adults
Acrochordus granulatus	90	23%	1.5	80-85%
Acalyptophis peronii	30	7%	0.5	80-85%
Aipysurus duboisii	1	<1%	0.02	100%
Aipysurus eydouxii	60	15%	1.0	5-10%
Astrotia stokesii	15	4%	0.25	0%
Disteria kingii	3	<1%	0.06	0%
Disteria major	1	<1%	0.02	100%
Enhydrina schistosa	20	5%	0.26**	50%
Hydrelaps darwiniensis	1	<1%	0.02	100%
Hydrophis elegans	15	4%	0.25	90-95%
Hydrophis coggeri(?)	1	<1%	0.02	0%
Hydrophis inornatus	1	<1%	0.02	0%
Hydrophis ornatus	1	<1%	0.02	100%
Hydrophis pacificus(?)	8	2%	0.16	0%
Lapemis hardwickii	150	38%	2.5	10-15%
Total	**397**		**6.6**	

*Catch rate (number of snakes per hour) based on 60 hours search time.
**Figure based on 75 hours search time.

Figure 2. *Enhydrina schistosa* caught by dip netting.



CAPTIVE REPRODUCTION IN THE SOUTH-WESTERN CARPET PYTHON, *MORELIA SPILOTA IMBRICATA*, INCLUDING AN EXCEPTIONAL FASTING RECORD OF A REPRODUCTIVELY ACTIVE FEMALE

by Brian Bush, 9 Birch Place, Stoneville WA 6081

INTRODUCTION

The only published data on reproduction in this subspecies is the unsuccessful record by Bush (1988) and a successful record referred to in Barker & Barker (1994) and Bush *et al* (1995). Maryan (1994) and the Western Australian Department of Conservation and Land Management (CALM), in its Policy Statement 29, both emphasise the need for more research into all aspects of this poorly known subspecies' biology. Pearson (1993) correlated observations from naturalists, amateur and professional herpetologists and CALM employees to determine the distribution and abundance of WA pythons. Along with Bush (1981) and Smith (1981), he suggested that *Morelia s.imbricata* numbers have declined since European settlement. Personal communications with several elderly, long-term residents of the Wheatbelt and Bunbury Regions of Western Australia reinforce this hypothesis. They reported that carpet pythons were often seen in their younger days but not, or only rarely, in recent times.

Here I report further successful captive reproduction in this subspecies, as well as an exceptionally long period of fasting demonstrated by a reproductively active female.

CAPTIVE HISTORY OF BREEDERS

Two females and one male had been together for at least five years before the observed reproductive behaviour reported here. The male in this study came from Lort River (33°44'S, 121°17'E) in October 1977. It had been with the larger female (Female 1) since her removal from a mineshaft near Norseman (32°15'S, 121°45'E) in December 1984. The smaller female (Female 2) came from Woodvale (31°48'S, 115°46'E) as a damaged hatchling in June 1988. Two additional males with snout-vent lengths of 96 cm (Mount Helena, 31°55'S, 116°16'E) and 108 cm (Wooroloo, 31°45'S, 116°20'E) were included in January 1992 and March 1993 respectively. This increased the number housed together to five (2 females, 3 males). These new males have not demonstrated any reproductive activity themselves, but may have stimulated the oldest male.

The 1977 male was the only member of this group to display any reproductive behaviour before September 1993. This occurred in 1984 and is reported in Bush (1988): it moved over the body of a female (kept at that time but not involved in this study) simultaneously with another male (released shortly after at Lort River), with both stroking her with their respective outstretched cloacle spurs. This was apparently stimulated by the introduction of the second adult male, and appeared to be a direct imitation of that male's behaviour. Only the recently introduced male was successful in inseminating the female.

Apart from an increase in the number of snakes housed together in this study, no other changes in husbandry preceding mating could be identified as the stimulus for observed reproductive behaviour.

I have never consciously attempted to breed *M. s. imbricata* as I use all my specimens of this python as tactile aids during my work educating people on reptiles. Almost daily during my lectures one individual or another is handled by many people. I thought that this alone would discourage reproduction. However, as this was not the case, it suggests that human-tolerant snakes suffer little stress from handling (see also Kreger & Mench, 1993).

MEDICAL

In early December 1991 the male and small

Female 2 had blood removed from the tail for biochemical analysis. They had this procedure done again in July 1994 along with all the other carpet pythons in my care. Nembutal was administered subcutaneously as a local anaesthetic during the first bleeding but not the second. I believe this procedure has reduced the prehensile strength of the tail in Female 2. Some difficulty in locating a blood vessel resulted in the tail being punctured several times with the needle, possibly damaging blood vessels, muscle or caudal vertebrae vital to adequate prehensility. Caution is therefore necessary when obtaining blood samples from caudal veins.

In late December 1991 all three pythons lost their appetites and began shedding mucus and blood in their faeces. This followed the introduction as food of a dead bronze-wing pigeon found on the road. The other snakes mouthed it before it was eventually swallowed by the older female. Believing an amoeba was involved I drenched them all with Metronidazole (Flagyl Suspension™) at the rate of 6 ml/kg and sent off a faecal sample to the pathologist. A flagellate, *Trichomonas* sp., was found in small numbers and the medication was changed to Dimetridazole ('Emtryl' Soluble™ 400g/kg). This was added to their drinking water at the rate of 4.5g to 7.5 litres. Within four weeks they were feeding and their faeces had returned to normal with no sign of micro-parasites. However, to be sure, I continued treating with the latter medication for the next four weeks. The pigeon is implicated as the source because *Trichomonas* causes 'canker' in these birds. It may reside in the crop without the manifestation of this disease (David Edmonds, pers. comm.).

CAGE AND FURNISHINGS

The snakes are kept in a glass-fronted wooden terrarium measuring (cm) 150 wide, 120 deep and 100 high. The furnishings are simple, consisting of two solid logs placed on a newspaper substrate, an electric blanket folded once as a heat source, an elevated hide-box and an eight litre plastic bucket of water. The electric blanket is permanently available as a refuge and is on from the beginning of May to December. All the pythons shuttle between the blanket and the hide-box. The cage sits directly on the surface of a 10 cm thick concrete floor out of direct sunlight in a steel colourbond shed. The natural photoperiod is continually interrupted by the intermittent opening and closing of the shed's sliding door.

No competitive male/male interaction was observed. A tolerance of other males at mating time occurs also in the subspecies *spilota* (Barker & Barker, 1994; Shine, 1991; Pers. obs. at Kangaroo Valley, NSW) and *M.s.metcalfei* (Shine & Fitzgerald, 1995), but not so in *M.s.variegata, M.s.cheynei* and *M.s.mcdowelli* (Barker & Barker, 1994, Shine, 1991). Male/male combat also occurs in *M.bredli* and *M.viridis* (Bumgardner, 1985; Fyfe, 1994; Walsh, 1977).

FEEDING AND FASTING

Most of the food provided was defrosted laboratory mice and rats. These are bought frozen from the Animal Resources Centre at Murdoch University, where they are reared in a sterile environment and fed a high protein, low fat diet. The only other food given, both alive and defrosted, were young rabbits and day-old cockerels bought occasionally from chicken hatcheries.

Food was offered every two or three weeks. The general pattern displayed by all my adult carpet pythons is to feed regularly for several months and then not eat for 3-10 months. When an individual is feeding food is provided ad lib.

Exceptional fasting was displayed by Female 1. After feeding on 27 August 1993, she was observed mating for the first time on 24 September. Two clutches of eggs were laid before this female next ate, on 7 January 1996, an interval of 28 months between feeds. The end of fasting occurred soon after a period of brooding behaviour, despite earlier removal of the second clutch of eggs.

During the fasting period, weight loss of the female was minimal, and when egg production is included weight gain occurred. In December 1991, female mass was 2.5 kg; in January 1994, immediately after depositing the first clutch, mass was 2.1 kg, and in December 1995, immediately after the second clutch was deposited, mass was 1.9 kg. total mass of the two clutches was 1.449 kg.

Presumably the apparent increase in mass reflects weight gain between December 1991 and the laying of Clutch 1 in January 1994, and/or water intake during fasting. Further, it demonstrates that normal metabolism is not a rapid drain on fat reserves.

This example of fasting does demonstrate the resilient nature of the animal. In especially harsh times, even when these are of considerable duration, the large adults within the population are able to persist and continue to reproduce, however, it is probable in extreme cases of famine, that there would be a low survivorship of any offspring. Alternatively, offspring would be feeding on much smaller prey, which may not be as scarce as that required by adults. In either case the species would be able to survive locally for considerable periods during food shortages.

EGG, INCUBATION AND NEONATE DATA

All eggs were incubated on vermiculite moistened with one part sterilised water to two parts vermiculite by weight. Four or five eggs were placed on this medium in 2 litre plastic ice cream containers. Cling wrap was pulled tight over each container and the lids replaced. These had a hole cut in the centre large enough to allow observation of all the eggs therein. Eggs were incubated at three temperatures (28, 29 and 30°C). Figure 1 shows a neonate emerging from egg. The failure of a sample of eggs in Clutches 1 and 3 may have been reduced if the eggs were incubated individually rather than as adherent clumps.

Data from three clutches are included here. Clutch 1 and 2 are from Female 1 and Clutch 3 is from Female 2. Pre-egglaying sloughs occurred 28, 21 and 22 days prior respectively. Post-egglaying sloughs occurred 46, 43 and 73 days after respectively. The reproductive effort, i.e. the clutch mass presented as a percentage of females' mass immediately after laying, was 37.7%, 34.6% and 38.7% respectively. Postnatal sloughs in all clutches occurred 15-23 days after hatching.

Clutch 1 Laid 15/01/94, N=17, female SVL 173 cm, weight 2.1 kg

Egg	Length (mm)	Width (mm)	Weight (g)
1	53	39	44.18
2	56	39	49.68
3	57	36	49.60
4	57	37	47.34
5	57	36	46.03
6	58	38	46.74
7	61	41	49.65
8	58	41	51.75
9	63	38	48.75
10	58	37	50.12
11	62	38	50.92
12	58	38	50.54
13-17 (mean)			41.44
Means	58.17	38.17	44.61

Eggs 13-17 adhered in a clump and were weighed and incubated as such.

Clutch 2 Laid 27/12/95, N=17, female SVL 181 cm, weight 1.9 kg

Egg	Length (mm)	Width (mm)	Weight (g)
1	50	37	38.00
2	50	36	49.00
3	50	38	49.00
4-8 (mean)	60	45	41.80

9-11 (..)	50	35	38.18
12-16 (..)	50	38	38.23
17 undeveloped			14.70
Means	53.13	39.44	40.11

Eggs 4-8, 9-11 and 12-16 were measured as three adherent clumps. Egg 17 was an undeveloped yellow 'slug' and not included in mean calculations.

Clutch 3 Laid 18/11/95, N=17, female SVL 171 cm, weight 1.96 kg

Egg	Length (mm)	Width (mm)	Weight (g)
1	62	36	
2	54	40	
3	56	42	
4	54	36	
5	68	35	
6	63	36	
Means	59.5	37.5	44.16

All eggs were adherent making it difficult to obtain a complete set of individual measurements.

Hatching occurred in

Clutch 1 after	63-71 days at	30°C
Clutch 2	63-69	30°C
..	69-74	29°C
Clutch 3	62-65	30°C
..	72-75	28°C

Different temperatures were recorded at different levels in the incubator resulting in skewed incubation periods.

Clutch 1 Hatching commenced 19/03/94, N=14

Neonate	SVL (mm)	Weight (g)
1	350	25.68
2	360	25.55
3	345	26.74
4	360	27.52
5*	346	29.80
6	372	30.50
7	360	24.89
8	355	24.14
9	365	38.36
10	345	26.82
11	348	25.97
12	353	26.52
13	355	26.10
14*	332	27.00
Means	353.28	26.88

* 5 and 14 died after slitting egg. The number of each has no relationship to the number adjacent to Clutch 1 eggs. Three eggs failed during the early stage of incubation.

Clutch 2 Hatching commenced 28/02/96, N=16

Neonate	SVL (mm)	Weight (g)
1	365	24.54
2	368	25.55
3	325	20.74
4	360	24.56
5*	346	23.88
6	372	25.97
7	343	23.49
8	370	26.54
9	365	24.54
10	372	26.35
11	353	24.70
12	368	24.89
13	365	23.45
14	338	21.30
15	335	21.30
16	336	24.81
Means	355.06	24.24

The number of each neonate has no relationship to the number adjacent to Clutch 2 eggs.

Clutch 3 Hatching commenced 19/01/96, N=12

Neonate	SVL (mm)	Weight (g)
1	350	23.67
2	340	25.78
3	355	25.33
4	353	26.46
5	365	27.72

6	350	26.65
7	360	28.00
8	355	27.57
9	350	28.12
10	340	26.78
11	345	25.73
12	353	26.26
Means	351.33	26.51

The number of each neonate has no relationship to the number adjacent to Clutch 3 eggs. Five eggs failed during the early stage of incubation.

ACKNOWLEDGEMENTS

I thank David Pearson for his comments and suggestions on an earlier draft of the MS, Glenn Shea for his comments and assistance in obtaining additional reference material and Dr David Edmonds (Eastern Hills Veterinarian Clinic) for information on canker in birds. None of this study would have been possible without the relevant licence and assistance provided by the Western Australian Department of Conservation and Land Management (CALM). Judy, my spouse, is a damn good person and deserves special mention for tolerating my passion and me for the past 30 odd years.

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PRELIMINARY OBSERVATIONS OF THE FRESHWATER TURTLE, *CHELODINA LONGICOLLIS* (SHAW), IN THE LONGNECK LAGOON CATCHMENT (HAWKESBURY - NEPEAN RIVER, NEW SOUTH WALES)

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ABSTRACT

The eastern long-neck turtle, *Chelodina longicollis* (Shaw), was sampled in September and October, 1993 from eight dams in the Longneck Lagoon Catchment, Hawkesbury - Nepean River. A total of 28 turtles were captured during the study. Sex ratios were significantly different to an expected 1:1 ratio ($X^2_{(1, 0.1)} = 2.79$). The 19 females had carapace lengths between 17.5 - 23.7 cm (mean 20.4 cm), weight ranged between 720 - 1132 g (mean 864 g). The nine males had carapace lengths which ranged from 16.2 - 21.3 cm (mean 19.1 cm), weight varied between 655 - 905 g (mean 783 g). All animals were emaciated, most were large, mature individuals. It is hypothesised that the population represents an aged, remnant population with no on-going hatchling recruitment and it is suggested that migration is inhibited due to unacceptable water quality (particularly on-going blue-green algal blooms) in the local reaches of the Hawkesbury - Nepean River.

INTRODUCTION

The eastern long-neck turtle, *Chelodina longicollis* (Shaw) is the most widespread and abundant freshwater turtle in Australia (Parmenter, 1985). Individuals of the species typically inhabit ephemeral waters (Kennett and Georges, 1990; Thompson, 1994) and under appropriate environmental conditions impoundments such as farm dams may form highly productive habitats for these turtles (Chessman, 1984). In times of environmental stress, animals migrate to more permanent waters (Georges, *et al.*, 1993; Kennett and Georges, 1990; Thompson, 1994). During extended drought high population density may result, with a sharp decline in growth rate and reproduction. After rain, turtles disperse to ephemeral waters where reproductive output is increased and growth is more rapid than in refugia areas (Kennett and Georges, 1990).

Despite a paucity of post-hatchling survival data, it is generally considered that under appropriate environmental conditions, hatchling growth is rapid over the first five to ten years. Upon sexual maturity, which is dependant on size and not age (Gibbons, 1982), overall growth rate slows, weight increases and the shell deepens. Despite individual variation, females tend to grow faster and ultimately attain a larger body size than males (Georges *et al.*, 1993). Females mature in about ten to eleven years at ≥17 cm carapace length and around 1080 g. Males generally mature at around seven years when their carapace length reaches ≥19 cm and they weigh approximately 1200 g (Parmenter, 1985).

Although there are few direct estimates, population structure would vary dependant upon past recruitment patterns (Georges *et al.*, 1993). Based on knowledge available, Georges (1985; Georges *et al.*, 1993) postulated that either there would be a 'sustained trickle' of young recruited to the population each year or, alternatively, there would be intermittent years when relatively large numbers of individuals would survive the hatchling stage. In some populations particular age cohorts would predominate, corresponding to

the intermittent years of relatively high recruitment compared with others with little or no recruitment. Alternatively a population may have equal numbers of juveniles and adults, representing a 'sustained trickle' pattern of recruitment.

Although susceptible to predation at all stages of their life cycle (Thompson, 1983), Cann (1993) suggested that the major environmental threat to freshwater turtles was the continued degradation of waterways, particularly in eastern Australia.

The Hawkesbury - Nepean is one of the most significant of these waterways and supplies 97% of Sydney's drinking water from its storage dams (Hawkesbury - Nepean Task Force, 1991). Many water quality studies attest to its degraded state (Burgin, 1993), however, limited data have been collected to assess the impact on the endemic aquatic fauna (Recker *et al.*, 1993). Although a study has been undertaken on the environmental impacts affecting frogs in the area (Ferraro and Burgin, 1993), no published work has addressed the impact of declining water quality on the freshwater turtles. This study provides information on *C. longicollis* sampled in a sub-catchment of the Hawkesbury - Nepean River: the Longneck Lagoon Catchment.

MATERIALS AND METHODS

Land holders in the area were approached, via letter drop, with a request for access to farm dams to assess turtle numbers. Permission was given to sample eight dams.

A variety of trapping methods were utilised: muddling and seine netting around the perimeter of the waterbody, hand capture with the aid of a dip-net, baited drum nets and the 'sit and wait' strategy. All captured individuals were marked with a unique combination of filed notches in the marginal scutes of the carapace based on the techniques of Cagle (1939). Carapace length (straight-line maximum) was measured with vernier callipers (± 0.1 mm) and body weight was measured with a 2 kg spring balance (Pesco, ± 5 g). Based on previous description of the external differences between sexes (Parmenter, 1977), sex was determined by examination of the posterior lobe of the plastron. As a measure of body condition, Parmenter's (1985) calculated size at maturity was utilised to compare with observed weight. Animals were released immediately after examination, at the point of capture.

The study was undertaken as a student exercise. Animals were captured and marked during the month of September and the second sampling period covered the first two weeks of October, 1993.

RESULTS

A total of 28 individuals were captured during the initial month of sampling and nine were captured in the second sampling period. All recaptured animals had been previously marked. The mean carapace length of the 19 females caught during the study indicated that all were probably mature (all >17 cm, range 17.5 - 23.7 cm; mean 20.4 cm: see Table 1). Their weight range was 720 - 1132 g (mean 864 g: see Table 1) which represented between 67 - 105% of the predicted weight at maturity. The size of the nine males varied between 16.2 - 21.3 cm (mean 19.1 cm: see Table 1), 67% were potentially adult. These individuals weighed between 655 - 905 g (mean 783 g: see Table 1), between 55 - 75% of predicted weight at maturity. The sex ratio of the sampled population was significantly different from the expected 1:1 ratio ($X^2_{(1, 0.1)} = 2.79$).

DISCUSSION

Based on a comparison of weight and size at maturity provided in Parmenter (1985), most individuals captured from the Longneck Lagoon Catchment were emaciated and most were large individuals. All females were probably sexually mature (ie., > 17 cm carapace length), together with most of the males encountered (16.2 - 20.7 cm, 66% >19 cm, see Table 1). Since the pattern of recruitment to the population implied by these data do not conform with that expected for a healthy population (outlined above), there may not have been recruitment to

the population for a number of years. It is, however, usual for hatchling numbers to be underestimated in turtle studies (Parmenter, 1985) but when a range of accepted sampling techniques are utilised, post-hatchling cohorts should be represented if they are present in the population. Indications are, therefore, that the population lacked sub-adults.

Females varied in weight between 67 - 105% of their predicted weight at maturity. The heaviest and largest female captured was 23.7 cm in length and weighed 1132 g (Table 1), compared with an expected weight at maturity of around 1080 g (carapace length ≥17 cm, Parmenter, 1985). Since the study was undertaken in September - October, normal healthy mature females should have been carrying large follicles and should therefore have been relatively heavier than after oviposition. All nine males captured were emaciated; weight varied between 55 - 75% of predicted body weight at maturity. The heaviest weighed 905 g and had a carapace length of 20.7 cm, compared with an expected weight at maturity of 1200 g, ≥19 cm (Parmenter, 1985: see Table 1). Under such circumstances, growth rates and reproduction would, at best, be greatly reduced. Individuals may therefore be older than predicted from their measured carapace length.

The ratio of males to females was significantly different from the expected 1:1 ratio. Kennett and Georges (1990) also noted a skewed sex distribution in a dune lake where animals were in poor condition but in habitat where food was plentiful, the ratio did not differ significantly from the expected ratio. Indications from these studies are that males are more susceptible to unfavourable conditions than females.

It may be assumed from the poor condition of the Longneck Lagoon turtles that they have been environmentally stressed for some time, possibly years, despite living in habitat which is typically productive for turtles. If the habitat was unproductive, the turtles would be expected to migrate and there are no apparent barriers to migration. *Chelodina longicollis* are also abundant elsewhere within the Hawkesbury - Nepean River floodplains (Burgin, unpublished data). It may be that turtles have remained in sub-optimal conditions, rather than move to the local reaches of the Hawkesbury - Nepean River which had been subjected to blue green algae blooms for more than three years at the time of the study (Hardiman, pers. comm.). Evidence for this hypothesis is scarce, since there has only been one published investigation of the decline of Australian freshwater turtles, undertaken in Lake Mokoan, Victoria (Cann, 1993). In a single year more than 600 dead turtles were collected from that lake's shores. It was concluded that the deaths were a result of a combination of starvation, in the presence of blue green algae blooms. Before the animals were found dead on the shores of the lake, no breeding had taken place for around ten years (Cribb, 1991). Our hypothesis is that the turtles in the Longneck Lagoon Catchment have been affected by the presence of blue green algae in the environment and we recommend that studies on the impact of declining water quality on freshwater turtles be undertaken.

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Table 1: Weight, length and sex of *Chelodina longicollis* (Shaw) caught in the Longneck Lagoon Catchment during September and October, 1993.

Sex	Carapace length (cm)	Weight (g)	Sex	Carapace length (cm)	Weight (g)
F	20.4	958	F	22.3	920
F	18.6	720	F	20.4	904
F	23.7	1132	F	22.9	975
F	20.3	895	F	18.1	725
F	19.2	800	F	21.1	890
F	19.8	802	M	19.4	790
F	18.6	720	M	20.7	905
F	20.9	900	M	19.4	790
F	20.1	935	M	18.8	720
F	19.5	790	M	16.2	655
F	19.4	790	M	18.3	725
F	21.8	902	M	16.7	660
F	17.5	720	M	21.3	895
F	22.4	930	M	20.7	905

SEASONAL ACTIVITY OF SOME SMALL GROUND-DWELLING LIZARDS AND FROGS IN A DRY OPEN FOREST NEAR TAREE, NEW SOUTH WALES.

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ABSTRACT

The seasonal activity of two species of frogs and two species of scincid lizards was studied over one year in dry open forest in Kiwarrak State Forest near Taree, New South Wales. *Lampropholis delicata* was most active during summer while *Pseudophryne coriacea* was most active during spring and summer. The remaining species, *Calyptotis ruficauda* and *Pseudophryne bibronii* were recorded in low numbers and no conclusions can be drawn on their seasonal activity.

INTRODUCTION

Seasonal activity of temperate Australian lizards and frogs has not been studied in great detail. Henle (1989) studied semi-arid populations of *Morethia boulengeri* and recorded activity all year round but reduced activity in summer due to excessive temperatures. Predavec and Dickman (1993) found twin peaks (spring and autumn) in activity in some desert frogs with reduced surface activity in both summer and winter. In temperate areas of Australia, lizards in particular are less active in winter months than during the other seasons while frogs tend to be more dependent on moisture and breeding site availability (Greer 1989, Pengilley 1972, Robertson 1980, Webb pers. obs.).

In 1976, the Forestry Commission of New South Wales commenced an investigation of the effects of repeated fuel reduction burning on the ground-dwelling vertebrate and invertebrate fauna of dry open forest in Kiwarrak State Forest near Taree, New South Wales. Unfortunately no post-burning sampling was carried (due to cessation of the project) out but sampling was conducted during the entire first pre-burn year of the study. This paper reports on the seasonal activity of two species of frogs and two species of scincid lizards present in the study area during the pre-burning phase of the study.

STUDY AREA AND METHODS

Kiwarrak State Forest is located immediately south of Taree (New South Wales). The forest has been selectively logged over the past 100 years, most recently in the early 1960's, together with removal of unmerchantable stems.

Vegetation of the area is predominantly dry open forest of *Eucalyptus paniculata* Sm., *Eucalyptus propinqua* H. Deane & Maiden and *Eucalyptus acmenoides* Schauer, with an understorey of Casuarinaceae and Acacia spp. and a relatively xeric shrub layer dominated by *Leucopogon juniperinus* R.Br. and *Breynia oblongifolia* J. Muell. (King 1985).

Twelve 50m x 50m plots were selected and 40 small pitfall traps were randomly located in each plot. Pitfall traps consisted of 375mL steel drink cans with the lid removed. These were sunk into the ground with the lip of the can flush with the ground. A plastic PVC cup was fitted into the top of each can to aid removal of contents. A preservative solution of propylene glycol and alcohol was added. Pitfall traps were active for 7 days in each of 4 sampling periods (April 1976, July 1976, october 1976 and January 1977).

RESULTS AND DISCUSSION

Two species of lizard (*Lampropholis delicata* and *Calyptotis ruficauda*) and two species of frog (*Pseudophryne bibronii* and *Pseudophryne coriacea*) were recorded in pitfall traps (Figure 1). The most abundant lizard (n=228 over the four sampling periods) was

L.delicata, and the most abundant frog (n = 73) was *P.coriacea*.

For *L.delicata*, abundance, as measured by pitfall trapping, was higher in the summer sample ($p<0.001$, 1-way ANoVA with sites as replicates) than in the other three seasons (Figure 1). For *P.coriacea*, significantly greater abundance was recorded during summer and spring ($p<0.001$) than in winter and autumn. For the two less common species (*P.bibronii* and *C.ruficaudus*), no significant difference ($p>0.05$) in mean captures was found between the four sampling periods due to the small sample numbers.

The large increase in captures of *L.delicata* during summer could be due to increased activity during this period but also to recruitment of juveniles. Unfortunately the relative contributions of these two factors could not be quantified but given that spring activity (as measured by pitfall captures) was similar to that of both autumn and winter then recruitment was probably a significant factor. Female *L.delicata* lay their eggs from october to March but predominantly January to February (Greer 1989, Jenkins and Bartell 1980, Pengilley 1972).

Little is known of the biology of *Calyptotis ruficaudis* and unfortunately little or no information can be gleaned from this study. Greer (1989) notes that *Calyptotis* spp. usually occur in moist woodland, they are cryptozoic and reproductively active in spring-summer (September to January).

P.coriacea was equally as active during spring as in summer. *Pseudophryne* spp. breed through most of the year provided adequate moisture is available (Pengilley 1973, White 1993, Woodruff 1976) but White records the greatest activity for *P.coriacea* in the November-December period which may explain the high capture rates in both the spring and summer samples. Unfortunately no conclusions can be drawn on the seasonal activity of *P.bibronii* as too few individuals were caught during the study. As frog activity and breeding generally depends upon favourable moisture conditions, it's likely that seasonal activity patterns may differ significantly from year to year.

ACKNOWLEDGEMENTS

Thanks are due to Ken Fairey, Gary King and the late Dr Hugh Dowden who were instrumental in the design and establishment of this study. Drs Hal Cogger and Allen Greer provided preliminary identification of frogs and lizards respectively.

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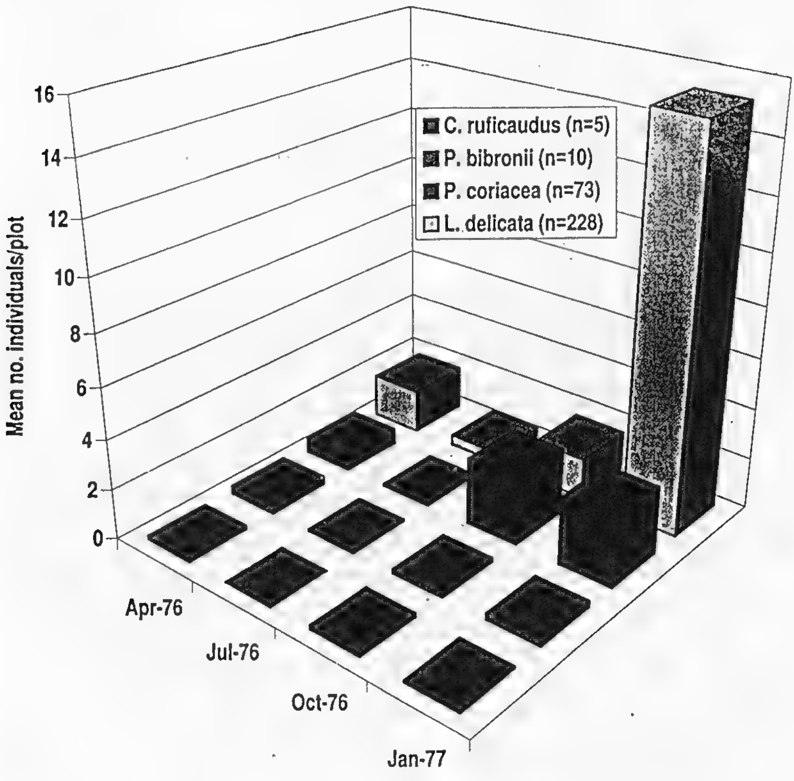
Figure 1.



IS "KING BROWN SNAKE" AN APPROPRIATE COMMON NAME FOR *PSEUDECHIS AUSTRALIS?*

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Several authors have remarked on the inappropriate or unreliable use of the vernacular name "King Brown Snake" for the common, widespread and colour variable species *Pseudechis australis* (Sutherland, 1981; Storr *et al.*, 1986; Underhill, 1987; Shine, 1991 and Cogger, 1992). Ehmann (1992) indicates a preference for Mulga Snake as an alternative common name. This is because *P. australis* is a member of the Black Snake Group (genus *Pseudechis*) and a reference to "brown snake" in its name may cause confusion, from a medical point of view with the Brown Snake Group (genus *Pseudonaja*). The antivenom for one genus will not neutralise the venom of the other (Sutherland, 1981). Here I present a view of the usage of this traditional name and some biological evidence for why it is appropriate for the northern tropical population of *P. australis*. For the purpose of this paper I describe the 'northern tropics' as an area encompassing the Kimberley region of WA, top end of the Northern Territory and east to the Gulf of Carpentaria in Queensland.

The application of the name 'King Brown Snake' is understandable when considering the type specimen originates from Port Essington, Cobourg Peninsula, Northern Territory (Cogger, *et al.*, 1983). People familiar with tropical zone *P. australis* will appreciate how their length and bulk make them an impressive snake. Many authors record the average total length for P. australis as 1.5 - 2 metres and sometimes exceeding 3 metres (Storr *et al.*, 1986; Wilson and Knowles, 1988; Cogger, 1992; Ehmann 1992 and Bush *et al.*, 1995). This large size probably refers to the tropical population. Graeme Gow (pers. comm.) considers that large King Browns are uncommon around rural Darwin. The average maximum length for the Top End N.T. is 2.1 - 2.8 metres with the occaisional 3 metre plus animal, however in areas where this species is under no pressure from man this species does exceed 3.5 metres G. Gow (pers. comm.). Two large snakes measured by him were 3.1 and 3.3 metres from near Darwin. Mr. Gow. also tells me of the biggest 'King Brown' he has ever seen near Katherine which was around 4 metres in length. I have heard anectdotal reports from Kimberley residents of snakes 4 metres in length. So large, in fact, that they thought it was a big python stretched across the track, only to find it was a king brown. The use of 'King' in reference to size is very appropriate for the northern tropical population only, as they are indeed Australia's largest venomous elapid.

Elsewhere in WA P. australis is relativel common up to 2 metres, especially in the Pilbara region, but never attains the bulk of its Kimberley counterparts (pers. obs.). In the Western Australian Wheatbelt specimens are quite slender and range between 1-1.5 metres in length. It has been hypothetically suggested to me that the disappearance of many small mammal species from the southern parts of their range has reduced their size due to less prey availability. However, the presence of introduced House Mice (*Mus musculus*) and rats (*Rattus spp.*) would more than compensate for loss of native mammal prey, thereby invalidating this theory. Further, all *Pseudechis* are catholic in foods habits. An examination of 162 prey items in 135 *P. australia* by Shine (1987) revealed a higher proportion of reptiles and frogs (115) then mammals (41). Considering that there is still an abundance of non-mammalian prey in southern Australia, this dietary analysis by Shine also contradicts the mammal-loss hypothesis. In Shine's data the most commonly eaten mammal was the

European house mouse.

Smith (1982) described the geographic colour variation in WA *P. australis* and highlighted the distinctiveness of the Kimberley population. The most obvious feature is the reduction in contrast between the anterior spot and darker apex of the dorsal scales. This population appears to be almost consistently monotonal brown, slaty grey or cream and agrees with the description provided by Gow (1977) as tan, light brown, brassy or reddish-brown for the Darwin area. Using these available colour descriptions and by examining illustratins (See Page 665 in Cogger 1992, from oenpelli NT) the paler brown colouration is a dominant feature of the northern tropical 'king browns'. Generally the colour of P. australis is variable and appears to be geographically influenced: northern snakes are lighter and southern snakes are darker (Mirtschin & Davis, 1982; Wilson and Knowles, 1988 and pers. obs.). I believe further investigation is required, into this geographical change in length, bulk colour and scalation as analysed by Smith (1982) in WA, but thoughout the range of *P. australis*. Despite the variation, Mirtschin and Davis (1992) state that scientific evidence from chromosomes, scalation, morphology and electrophoretic patterns of blood proteins supports the retention of all populations in P. australis. Wells and Wellington (1983) are of an opposite opinion in the extreme but provide no justification for their taxonomic treatment. Not only do they remove *australis* and *colletti* from *Pseudechis*, but recognise three synonymies of *australis* as distinct taxa, restricting the type population to the northern sector of the Northern Territory.. This taxonomic dismemberment is refuted by Mengden *et al.* (1986) stating the division of the genus *Pseudechis* would obscure the biological reality of its adaptive radiation and is clearly inconsistent with the available scientific evidence.

I am unaware of any published captive breeding records of the tropical northern population of *P. australis*, therefore captivity data is very limited. Based on my experience raising two siblings of opposite sex from a clutch documented by Bush (1995), the growth rate in this population particularly the males in captivity, is a very rapid one. I received the sibling male on 16 April, 1994 (hatched 27 January). It was 246mm SVL and weighed 8.49gm. For the first year its growth was gradual, doubling in weight every 3-4 months. By September 1995 it had attained 330gm and then a growth explosion occurred. It became a king brown! By 14 December 1996 (14 months) it measured 2.0 metres and weighed 3.0kg: The parent male from Kununurra, Western Australia (15°46'S 128°44'E) at the time of mating in September 1993 was 850mm in total length. In April, 1996 it measured 2.1 metres with considerable bulk. A 1.8 metre male collected near Darwin, Northern Territory in 1990 now measures an impressive 2.5 metres and 6kg (C. Stephenson pers. comm.). Some growth rate examples from different regions of WA are a 50cm male in 1982 from Port Headland (20°19'S 118°36'E) that after 14 years of captivity is now 2 metres (B. Bush pers. comm.). I have maintained a 1 metre female since october 1993 from Kelleberrin (31°38'S 117°43'E) which has only gained an extra 30cm and is 761gm. By comparison the sibling female from Bush (1995) is 1.2 metres and 1.08kg. It is apparent that the tropical northern form of *P. australis* grows to a much larger size than its southern counterparts and its comparitive growth is also much more rapid.

Based on the entrenched usage of the name 'king brown', its apparent widespread acceptance and the refence to size and colour, it is appropriate for the northern population of *P. australis* only. The major problem, with the use of this common name, as indicated by Sutherland (1981), is in the management of snake bite. As this species is widespread throughout Australia it should be standard practice for most major hospitals to hold polyvalent antivenoms with black snake constituents. I believe the dropping of "brown" has some merit from a medical point of view. However, like most herpetologists I like King Brown and cannot imagine any other name being as widely accepted.

ACKNOWLEDGEMENTS

I thank Brian Bush, Harald Ehmann, Graeme Gow, Paul Horner and Peter Mirtschin for their valued comments on this manuscript.

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COMPARATIVE ABNORMALITY RATES OF THE TRILLING FROG AT OLYMPIC DAM

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ABSTRACT

Trilling Frogs (*Neobatrachus centralis*) were sampled at Olympic Dam in northern South Australia following heavy summer rains in early 1997. The type and incidence of skeletal abnormalities were recorded from a total of 1249 frogs and 143 metamorphlings. Abnormality rates in all samples were attributed to natural processes and were higher in frogs metamorphosing in 1989 compared to those from later cohorts. Although they are very sensitive to a range of toxins, frog abnormality rates did not indicate any significant environmental contamination associated with the Olympic Dam mine and processing plant.

INTRODUCTION

Frogs are important tools for environmental monitoring due to their abundance, ease of sampling, and their predisposition to exhibit clearly discernible abnormalities following exposure to environmental contaminants (Tyler 1989, Ouellet *et al.* 1997). The versatility of frogs as bioindicators is enhanced by their sensitivity to a range of pollutants, including trace elements, heavy metals, radiation, sewerage and some pesticides (Nishimura 1967, Hazlewood 1970, Browne and Dumont 1979, Henle 1981, Mizgireuv *et al.* 1984, Power *et al.* 1989, Tyler 1989, Ouellet *et al.* 1997).

For these reasons, monitoring frog abnormality levels is an important component of the environmental monitoring at the Olympic Dam mine. WMC (Olympic Dam Corporation) manage the extraction and processing of a large underground copper, uranium, gold and silver deposit, approximately 520 km north of Adelaide in the South Australian arid zone (30°29'S, 136°53'E). Significant rainfall can occur in any month but is highly unpredictable, averaging only 166 mm per year. The Trilling Frog (*Neobatrachus centralis*) is the only frog species recorded from Olympic Dam (Read 1994). However, this medium-sized burrowing frog is the most abundant vertebrate in the region and is widespread throughout most local habitats (Read 1992).

Trilling Frogs are only active for several nights following infrequent and erratic heavy rainfall events. Long periods of inactivity are spent underground, encased in a semi-permeable cocoon. Whilst some individuals emerge following showers of only 5 mm (Read 1992), rains of approximately 40 mm are generally required to stimulate activity in the bulk of the population. Large scale frog abnormality studies are conducted at Olympic Dam during these occasions when large numbers of frogs are active. Approximately 140 mm of rain from February 5 to 9, 1997, following 21 mm on 22 January 1997, provided the impetus for broad-scale frog activity and hence permitted a local abnormality survey. This study represents the third in a series of studies documenting abnormality levels in different cohorts of Trilling Frogs at sites near and remote from the Olympic Dam mine (Read and Tyler 1990, Read and Tyler 1994).

METHODS

Frogs were collected by hand in temporary ponds at night time when they had concentrated to spawn. In addition, free-ranging frogs were collected along bitumen roads at night time and by pitfall trapping. Samples potentially influenced by the mining activity were collected from four ponds within 200 m of the mine ventilation ducts or the processing plant and from roads within 1 km of the mine and

plant. Control samples were collected from roads and two ponds greater than 10 km south of the mine and processing plant, and a pitfall site in chenopod shrubland 5 km east of the mine. A second pitfall site, called the "PITGRID", was located 3.8 km north of the mining operation but could not automatically be considered a control site because it lies along the prevailing wind direction from the mine. The habitats and trapping layout of this PITGRID site are presented in Read (1995). All roads and ponds were sampled on February 6, 1997 and February 14, 1997 respectively whereas the control pits and PITGRID samples were collected on January 22, 1997.

An additional collection of frogs from a pond near the mine was made on March 4, 1997, when the bulk of the metamorphlings were emerging. Most metamorphling surveyed were fully metamorphosed, Gosner (1960) developmental stage 46, although a few individuals still exhibited a tail stub. Metamorphlings were not collected from control regions since the background abnormality rate has now been established from 1200 frogs in the local region.

Collected frogs were held overnight in large open plastic containers and buckets containing 1-2cm of water at densities allowing all individuals access to the water without crowding. Samples from each location were kept separate and released the following evening at their place of capture. Although frogs were not individually marked, restricting collection to single nights in different regions eliminated the chance of resampling individuals. All individuals were weighed to the nearest 0.1g on a balance and their snout-urostyle length (SUL) was measured to the nearest mm on a ruler by pushing down on the nuchal region until the head was horizontal. These measurements were used to assign frogs to age cohorts. Due to short recruitment periods separated by long periods of reproductive inactivity, age cohorts of desert frogs can be followed for several seasons by measuring the size distribution of the population (Tinsley and Tocque 1993). Frogs were carefully inspected by eye for gross external abnormalities and presence of nuptial pads or eggs.

RESULTS

Two distinct size cohorts could be recognised from the 1249 Trilling Frogs sampled from January 22, 1997 to February 6, 1997. The smallest cohort of frogs measured 34-38mm with a mode of 36mm and could be attributed to the last major recruitment of *N. centralis* in 1992. The larger cohort measuring 40-46mm (mode 42mm) recruited in March 1989. Frogs measuring 39mm (5.6% of the sample) or greater than 46mm (3.2% of the sample) could not be assigned to cohorts with confidence. Due to the considerable baseline data on the nature and incidence of control frog abnormalities collected on previous local surveys (Read and Tyler 1990, 1994), most effort was expended sampling frogs near the mining operation, hence only 30% of frogs came from true control locations.

Overall abnormality incidences in adult frogs from the mine sites were 3.5% compared with 1.3% and 1.4% at control sites and the PITGRID respectively (Table 1). Abnormality rates were considerably higher in samples collected from ponds than terrestrial sites in both mine and control regions. Three (2.1%) of the 143 metamorphling frogs exhibited abnormalities and the nature of the foot deformities in two of the specimens would probably prohibit effective burial and hence be life threatening. Therefore, metamorphling frogs may exhibit considerably higher abnormality rates than adults. If the two potentially fatal abnormalities were excluded, the projected abnormality rate from an adult sample of this population would be reduced to 0.7%.

Of the frogs sampled from the mining region in 1997, abnormality frequency was higher in the 1989 recruitment than the 1992 or 1997 recruitments from the mining region (Table 2).

In accordance with previous studies, most (81%) abnormalities detected from all samples involved partial ectrodactyly, expressed as shortening of a single digit. This contrasts with the gross deformities recorded from heavily contaminated sites in Europe (Henle 1981)

Table 1. Details of abnormalities detected. (Digits are numbered from inside to outside on either L (left) or R (right), H (hand) or F (foot), shortening is ascribed to partial ectrodactyly)

Location	Type	Sample Size	Abnormality	Sex	SUL	Cohort	Incidence of Abnormality
Minesite	Ponds	454	LH4 short	M	42	1989	3.96%
			LH4 short, right eye missing	M	37	1992	
			LH4 short, RH2 tip bifid	M	43	1989	
			LH3&4 fused	M	43	1989	
			LH3 short	F	41	1989	
			LH3 short	M	45	?	
			LH3 short	M	39	?	
			LH2 short	M	40	1989	
			LH1,2,3 short	M	41	1989	
			RH4 short	M	43	1989	
			RH4 short	M	41	1989	
			RH4 short	M	41	1989	
			RH4 short	M	41	1989	
			RH4 & RH2 short	M	37	1992	
			RH3 short	M	40	1989	
			RH1 short	M	40	1989	
			RF3 short	M	41	1989	
			LF4 short	M	38	1992	
Minesite	Terrestrial	208	LH4 short	M	39		2.40%
			LH4 short	F	41	1989	
			RH2 short	F	42	1989	
			RH3 short	M	44	1989	
			LF4 short	M	41	1989	
Minesite	**Total**	**662**					**3.47%**
Control	Ponds	109	LH4 short	M	37	1992	2.75%
			LH4 short	F	43	1989	
			RH3 bifid	M	38	1992	
Control	Terrestrial	265	RH3 short	F	48	?	0.75%
			RF4 short	M	36	1992	
Control	**Total**	**374**					**1.34%**
PITGRID	Terrestrial	**213**	LH4 short	?	36	1992	**1.41%**
			RH3 short	?	38	1992	
			LH2, RH2 short	?	38	1992	
RB10 Pond	**Metamorphlings**	143	missing all digits on LF	?	21	1997	**2.1%(0.7%)***
			LF4 short	?	20	1997	
			RF twisted & webbed to thigh	?	18	1997	

* Although the abnormality rate was 2.1% the equivalent deformity rate in adult populations is probably 0.7% due to the likely fatal nature of two of these deformities.

Table 2. Abnormality rates in different age cohort of frogs from the mine and control regions.

Location	Sample size	Cohort	Incidence of Abnormality
Mine	571	1989	3.2%
MIne	175	1992	1.7%
Mine	143	1997	2.1%(0.7%)*
Control	245	1989	0.4%
Control	201	1992	3.0%
Total	**1335**	**combined**	**2.3%(2.2%)***

*Abnormality rate projected for adult populations when metamorphlings with fatal abnormalities are excluded.

DISCUSSION

This study contributes to the growing data set on abnormality levels in frog populations. Abnormality rates reported here fall within the range previously recorded at Olympic Dam (Read and Tyler 1990, 1994), and are within the range or slightly higher than most reported for natural populations by Tyler (1989). Abnormality rates were less than the 5.1 and 5.8% reported for two other natural arid-zone sites in Australia (Roberts 1985, Read and Niejalke 1996) and considerably less than from contaminated sites on other continents which typically exceeded 10% (Henle 1981, Mizgireuv *et al.* 1984, Vershinin 1989, Quellet *et al.* 1997). The nature of the abnormalities recorded from other localities which include up to 10 supernumerary limbs (Sessions and Ruth 1990) and a wide range of other gross skeletal anomalies (Tyler 1989).

Most developmental defects in frogs typically occur on hind limbs (Mizgireuv *et al.* 1984, Ouellet *et al.* 1997) due to their greater exposure to exogenous insults than forelimbs (Sessions and Ruth 1990). Therefore, the higher ratio of deformities in forelimbs to hindlimbs (27:7) further suggests that abnormalities observed at Olympic Dam were not the result of environmental contaminants. The incidence of limb deformities in frogs may increase through infestation of trematodes in tadpoles (Sessions and Ruth 1990), or other causes unrelated to mining impacts, which reinforces the need for large sample sizes when conducting these studies (Ouellet *et al.* 1997).

The incidence of abnormalities near the mine in 1997 was exceeded by that recorded from a local control site in a pilot survey in 1989 (Read and Tyler 1990), which suggests that the percentage of abnormalities near the mine fall within natural variation of the local population. In addition to comparing abnormality rates from several regions at the one time, useful information can be derived by comparing abnormality rates from different age cohorts collected from the same sites. If contaminant levels in ponds had reached toxic levels through accumulation of mining emissions, the 1992 and 1997 cohorts at mining sites would be expected to yield higher abnormality rates than older frogs. However, abnormality rates in both the 1992 and 1997 cohorts were lower than those from the 1989 cohort collected near the mine. Higher overall deformity rates in adult frogs in the vicinity of the mine compared to control sites in the 1997 survey are therefore attributed to natural variation and do not provide evidence of increased levels of toxins in the local environment.

The exhibition of two potentially fatal abnormalities in metamorphlings reinforces the findings of Tyler (1989) and Ouellet *et al.* (1997) that juveniles demonstrate higher abnormality rates than adults. Therefore, abnormality rates in metamorphlings of burrowing frogs may overestimate rates in adult populations which must be taken into account when comparing the incidence of deformities in adult and juvenile cohorts.

This study supports ecological studies on other animal groups that suggest that Olympic Dam Corporation has not had a significant pervasive impact on the fauna community adjacent to the mining operation (WMC 1996, Read 1996).

ACKNOWLEDGEMENTS

I thank Katherine Moseby and Kelli-Jo Lamb for their assistance with collecting and processing the large samples of frogs. Katherine Moseby also provided useful comments on a draft of this manuscript. This study forms part of the Environmental Monitoring and Management Programme of WMC (Olympic Dam Corporation).

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BEHAVIOUR OF THE BEARDED DRAGON LIZARDS *POGONA BARBATA* AND *P. VITTICEPS* IN CAPTIVITY.

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ABSTRACT

Head bobbing in male *Pogona vitticeps* varied with respect to situation. Rapid head bobs were given when mating and slow ones during stalking and predator monitoring. Behaviour associated with thermoregulation included eye bulging and air gulping.

INTRODUCTION

Observations of the mating behaviour in captivity of a female eastern bearded dragon *Pogona barbata* with a male central bearded dragon *P. vitticeps* are presented. The male displayed a range of complex and varied behaviour, which included courtship, mating, territoriality, stalking of prey, thermoregulation and conditioning. The female was less overt and displayed courtship, mating, thermoregulation and submissive behaviour.

The aim of the study was to gain information on the behaviour of captive animals that may be used as a basis for field research.

METHODS

Observations were made between October 1972 and January 1974 on animals housed in a 3 x 3 x 1 m outdoor enclosure made of corrugated iron, located at Sydney, New South Wales (NSW). The enclosure was landscaped with sandstone slabs, a pond and a dead vertical branch approximately 1.5m in height. Vegetation within the enclosure consisted of the exotic grasses paspalum *Paspalum dilatatum* and buffalo *Stenotaphrum secundatum*. The observer sat next to the enclosure.

The male, a *P. vitticeps* was from the Tamworth area in NSW. The female *P. barbata* was from Sydney. Additional *P. barbata* were also from Sydney. other animals housed within the enclosure included blue tongues *Tiliqua scincoides* and water dragons *Physignathus lesueurii*.

RESULTS

Mating Behaviour

The female was captured 16 September 1972 at 1.30 pm and placed in the enclosure with the *P. vitticeps*. Mating took place immediately and the sequence of behaviour is summarised in Tables 1 and 2.

Upon seeing the female, the male descended the branch and approached her. He stopped 600 mm from her and changed colour. From monotone grey, the distal half of his tail, gular region and chest became black and the rest of his body fawn. The female's colour was similar except her tail, gular region and chest was less intense.

The male began a series of rapid head bobs where the skull looked as if it had been dislodged from the vertebral column (Kinghorn 1931). The male also began to forearm stamp. Forearm stamping was a rapid, simultaneous elevation and lowering of both forelimbs. It was a vigorous display that was audible when the animals hands hit the ground. Rapid head bobbing and forearm stamping occurred simultaneously and separately.

The male then extended his gular fold while keeping his mouth closed. The extension of the gular fold differed from the typical aggressive/defensive display described by Brattstrom (1971). In the aggressive/defensive display the gular fold is extended out and forward whereas in this instance the 'beard' was extended mid-ventrally. He then circled the female at a distance of approximately 10 cm, head bobbed and forearm stamped.

The female barely moved throughout these displays. Her gular fold was slightly raised and the pigmentation of the distal half of her tail, chest and gular intensified.

The female began to 'circumduct' (Carpenter *et*

al. 1970) her forearms. one forearm was raised, circumducted (the rotation of an arm at the shoulder joint) and lowered. This action was repeated several times with alternate forearms. The female had raised her gular fold and her mouth was slightly ajar. Her body was flattened which enlarged the dorsal surface.

She then used her hind limbs to move approximately 30 cm. This took the form of a sliding movement where her belly was kept in contact with the ground while the front half of her body was raised by the forearms being kept fairly straight. Her head also maintained an elevated position while she slid.

The male orientated himself in the 'face-off position' (Carpenter *et al.* 1970) to the female. He lashed her face with his tail while she repeatedly bit it. The male then grasped the female's tail with his mouth several times. The biting did not appear to injure either animal.

The male reorientated himself and bit the female's nape as he mounted. When the male had mounted the female again propelled herself in the sliding fashion described above. The male meanwhile continued to bite the female's neck and circumducted his forearms rapidly. This 'front leg flap' (Brattstrom 1971) was quite distinct from forearm stamping or normal circumductions. The forearms were not elevated to the degree of these previous two motions but rapidly 'pawed' the air. The male thrashed his tail while mounted and the female circumducted alternate forearms while she slid along the ground.

Copulation occurred while the pair were moving in the sliding run. During intromission the male's left hind foot rested on the upper side of the female's thigh and his right foot was on the ground. The male's tail was orientated under the female's so that their cloacas met. After mating the male released his bite on the female's nape, dismounting and both animals head bobbed slowly a few times.

Copulation was frequently observed between the 16 September and November 1972 and often occurred several times per day. Subsequently scar tissue formed on the females nape. The female became gravid (eggs were palpated) and oviposition occurred on the 10 November 1972, some 56 days after the initial mating. The eggs were not located and did not hatch. on the 30 January 1973, 6 February 1973, 3 and 13 March 1973 the male attempted to mate but copulation was not observed. The male courtship behaviour described above was displayed prior to all mating and attempted mating events. Copulation resumed on the 18 August 1973.

Aggressive Territorial Behaviour

The male spent most daylight hours perched on top of the 1.5m dead branch and descended to feed, mate, sleep and when adult male *P. barbata* were placed into the enclosure. The branch functioned as a lookout.

When male *P. barbata* were put into the pit the *P. vitticeps* would descend rapidly from the branch, approach the intruder, give a 'challenge' head bob and arm wave then orientate in the face off position and tilt his inflated body towards the intruder. This challenge was followed by biting the other dragon's head.

The male *P. barbata* never made a challenge or displayed submissive arm waves as described by Carpenter *et al.* (1970). Several male *P. barbata* were introduced into the enclosure at staggered intervals and all received a similar treatment from the *P. vitticeps*. All introduced *P. barbata* tried to escape, even those which were larger than the *P. vitticeps.*

Thermoregulation

The male often displayed 'eye bulging' during early morning thigmothermic basking when positioned vertically against the warm iron enclosure wall. During eye bulging, the area around the orbit was expanded such that the eye appeared hemispherical and the eyelids were closed. After eye bulging the nictitating membrane was extended over the eye several times. Eye bulging lasted for approximately one minute but was often repeated.

Another behaviour displayed by the male dur-

ing early morning thermoregulation was 'air gulping'. The head was elevated and the gular fold inflated while the mouth remained closed. The head was lowered and the gular fold partially deflated. This process was repeated several times and the body took a spheroid shape that was quite different to that taken during a threat display or the simple flattening described by Bustard (1970). Air gulping was only observed in association with early morning heliothermic basking when the lizard had postured itself to receive maximum exposure to direct sunlight.

There was a seasonal shift in where the animals slept. During summer the male slept while perched on his lookout while during winter he slept in the grass. The female slept in the grass during summer and constructed a cavity approximately 7 cm beneath the surface of the earth during winter. She remained in this cavity from the 10-23 May 1972. After being disturbed on the 23 May 1972 she slept in the grass for a few days but then returned to the cavity and hibernated for about 40 days.

Feeding and Stalking Behaviour

During autumn the *Pogona* were fed crickets *Teleogryllus commodus*. The insects were dropped individually into the corner of the enclosure. on seeing the cricket the male would slowly head bob and descend from his lookout. The cricket would be encouraged to move by prodding it with a 1.2 m stick. Movement of the cricket stimulated the lizard to lunge forward and catch it. The stick was also used to move dandelion *Taraxacum officinale* flowers which the lizards also ate.

After a period the presentation of the stick was sufficient to cause the male to descend from his lookout and rush towards it. Rapid small movements of the stick caused him to lunge at it. The female exhibited no such behaviour.

Stalking was only displayed when live food or the stick was presented and was displayed more frequently by the male. It consisted of the lizard running to within 30 cm of the food, a slow head bob (or two), turning the head to the side for a few seconds, reorienting the head, several more slow head bobs and then tail twitching (the raised distal half to quarter of the tail was moved laterally, see Carpenter *et al.* 1970). The rapidity of the twitch increased as the lizard opened its mouth, extended its tongue and then lunged toward the food.

Occasionally stalking incorporated arm waving which mostly occurred between the latter head bobs and tail twitching. Stalking did not occur if the cricket continually moved or if several crickets were placed within the enclosure at the one time. In the latter situation the crickets were rapidly caught and eaten with only the occasional head bob.

Some food was held in the gular fold and swallowed later. occasionally the male would complete feeding, move to an elevated position on the sandstone rocks and lick the substrate. Licking of the substrate was observed more frequently in hatchling *P. barbata* than adult *P. barbata* or *P. vitticeps*.

Placing hatchling *P. barbata* into the enclosure initiated stalking by the male. But when he approached the juvenile he did not eat it but only licked its head. No *P. barbata* hatchlings were observed to be eaten by adult *Pogona*, however a male *P. barbata* was observed to eat a jacky *Amphibolurus muricatus* in captivity.

Predator Avoidance

Ten species of raptor are known to take *Pogona* sized dragons (Marchant and Higgins 1993). Bearded dragons are aware of large birds and both *P. barbata* and *P. vitticeps* would continually tilt their head to observe the sky. If a bird of prey or raven was seen the male would reduce his surface area, press his body against the lookout, freeze and change from fawn to a monotone grey. The potential predator was continually watched until it left the area. Even a small raptor, such as the nankeen kestrel *Falco cenchroides* would elicit this response. *Pogona barbata* and *P. vitticeps* in the field also use this behaviour when approached by humans.

Table 1. Sequence of male *Pogona vitticeps* courting behaviour.

Behaviour	Present Study	Brattstrom (1971)	Carpenter (1970)	Kinghorn (1931)
Rapid head bob	*	-	-	*
Forearm stamping	*	-	-	*
Mid vertical gular extension	*	-	-	?
Premating circling	*	-	-	*
Tail-lash face	*	-	*	-
Male bites female's tail	*	-	-	-
Male straddles female	*	-	-	-
Male bites female's nape	*	*	-	*
Front leg flap	*	*	-	*
Tail wriggling	*	-	-	*
Post mating slow head bob	*	*	-	*

Table 2 Courtship Behaviour of female *Pogona barbata.*

Behaviour	Present Study	Brattstrom (1971)	Carpenter (1970)	Kinghorn (1931)
Torso flattening	*	-	-	*
Forearm circumduction	*	-	-	-
Gular extension	*	-	-	-
Precopulatory head elevation	*	*	-	-
Hind limb slide	*	-	-	*
Female bites male's tail	*	-	-	-
Post mating slow head bob	*	*	-	-
Head Roll	*	*	-	-

Terminology where applicable is based on Brattstrom (1971).

DISCUSSION

Head bobbing was common to *P. barbata* and *P. vitticeps* and the behaviour has been observed in other species of Agamid such as water dragon *P. lesueurii*, forest dragons *Hypsilurus boydii* and *H. spinipes* and *A. muricatus* (pers. obs.). Head bobbing is widespread over several genera of Australian dragons.

In the case of *P. vitticeps* and *P. barbata* head bobbing was displayed during courtship, territorial interactions, during the stalking of live food items and when lizards observed potential predators. Head bobbing varied in speed with respect to function, being rapid during courtship and slow in order to obtain stereoscopic vision during stalking and predator monitoring. The speed of head bobbing may have several functions in social communication.

Pogona species have the ability to make circulatory adjustments in relation to rates of heating and decreased rates of cooling (Bartholomew & Tucker 1963). Blood appears to be shunted to large sinuses in the head when basking begins (Greer 1989). This may account for 'eye bulging'. Expansion of blood vessels around the orbit would allow the brain to heat rapidly to an optimal temperature. In this case the nictitating membrane may serve as an inflatable reservoir. Eye bulging was observed by Bartholomew and Tucker (1963) when *P. barbata* were heat stressed at 40°C and its use in initial thigmothermic basking has been recorded in the spotted dragon *Ctenophorus maculosus* (Mitchell 1973).

Air gulping was associated with thermoregulation but its specific role is yet to be determined.

Crosses between captive *P. barbata/vitticeps* have been recorded and the resulting hatchlings showed minor non-lethal deformities (Badham 1976). If *P. barbata/vitticeps* are sympatric over part of their range the current observations begs the question: does behaviour act as an isolating mechanism in sympatric sibling species? Field based studies will hopefully resolve such issues.

ACKNOWLEDGMENTS

The article was kindly reviewed by G. Torr and P. Harlow. G. Swan also made valuable comment on the paper.

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RECORDS OF THE MARSH SNAKE *HEMIASPIS SIGNATA* NEAR NOWRA, NSW: A SOUTHERN EXTENSION OF THE KNOWN RANGE OF THE SPECIES.

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The Marsh Snake *Hemiaspis signata* occurs along the coast and ranges of eastern Australia from far northern Queensland to the south coast of New South Wales (Cogger 1992). Prior to 1994 the southern-most records in the Australian Museum were from Robertson (specimen R6184 registered in 1913 and since destroyed) and Coniston near Wollongong (specimen R12313 registered in 1938). Swan (1990) listed Coniston as the species' southern limit. This paper documents a number of records from the Nowra area, extending the known range of the species by over fifty kilometres.

Nine records of *H.signata* from the Nowra area are known to the authors. Information concerning these records is summarised in Table 1 and Figure 1.

Table 1: Records of *H.Signata* near Nowra NSW

Record	Date	Locality	Habitat	Alt	Lat & Long	Capture	Source
1	1978	Beecroft Peninsula	coastal heath	55m	35°03'S 150°48'E	under concrete slab	(Coyne *et al.*1979)
2	1978	Beecroft Peninsula	coastal heath	85m	35°04'S 150°49'E	during fire	(Coyne *et al.*1979)
3	1987	Vincentia	coastal heath	80m	35°05'S 150°40'E	in hollow log	(Merdith pers. comm.)
4	1989-95	West Cambewarra	cleared land	175m	34°49'S 150°30'E	under logs and sheets of iron	(Daly 1995)
5	1990	Huskisson	open forest	20m	35°02'S 150°39'E	under sheet of iron	(Torr pers. comm.)
6	1992	Callala	open forest	5m	35°01'S 150°40'E	under rubbish	(Goldingay pers. comm.)
7	1994	7 Mile Beach National Park	open forest	5m	34°49'S 150°44'E	roadkill	(Murphy 1994)[1]
8	1994	Culburra	open forest	5m	34°55'S 150°45'E	under sheet of iron	(Daly 1994)
9	undated	Tianjara Falls	woodland	490m	35°07'S 150°20'E	unknown	CSIRO[2]

1 Australian Museum specimen R143568

2 CSIRO Australian National Wildlife Collection specimens R3115 and R3116.

It was considered possible that the specimens from Tianjara Falls may have been misidentified White-Lipped Snakes *Drysdalia coronoides*, but they were recently reexamined and confirmed as *H.signata* by Wombey (pers. comm. 1996).

Future field work south of the Nowra area may further extend the known range of *H.signata*. However, the species was not recorded during an extensive survey of the reptiles and amphibians of the coastal forests near Bega, NSW (Lunney and Barker 1986).

ACKNOWLEDGEMENTS

We thank Ross Goldingay, Graham Merdith and Geordie Torr for the use of their personal records, Ross Sadlier and John Wombey for information on specimens in the Australian Museum and CSIRo collection, and Darryl Houston and Geordie Torr for helpful comments on the draft manuscript.

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Figure 1: Map of the Nowra area showing the location of *Hemiaspis signata* records. Records numbered as per Table 1.

THE INGESTION OF SLOUGHED SKIN BY MEMBERS OF THE GENUS *EGERNIA* (SCINCIDAE).

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INTRODUCTION

The ingestion of the shed epidermal layer (dermatophagy) is known to occur in a number of squamate reptiles, particularly lizards (see Bustard & Maderson 1965, Weldon et al. 1993). Notable among the Australian lizard fauna to exhibit this behaviour are skinks of the genus *Egernia* (*E.whitii*, Hickman 1960; *E.cunninghami*, Barwick 1965, Shine 1971, Brown 1991; *E.striolata*, Bustard 1970; *E.inornata* and *E.striata*, Pianka & Giles 1982). The behaviour has largely been inferred from the presence of sloughed skin in the alimentary tracts or faecal pellets of free-ranging lizards (Hickman 1960, Bustard & Maderson 1965, 1970, Pianka & Giles 1982, Brown 1991, Shea 1995). It raises the question as to whether the ingestion of sloughed skin is intentional or merely accidental (i.e., is consumed during fighting or during feeding when disgarded skin adheres to food, etc.). This latter possibility is quite plausible given that some *Egernia* species live in small groups (Greer 1989 pp.128-31, Hutchinson 1993 and references therein) where individuals would regularly encounter each other as well as their own, and other individuals, sloughed skin. Clearly direct observation of ecdysis in members of the *Egernia* would help to resolve the question. Accounts of ecdysis in the *Egernia* are presently few (see Barwick's (1965) account of sloughing in *E.cunninghami*). In this note I describe the sloughing process in the Black Rock skink, *E.saxatilis intermedia*, and present observations also on ecdysis in the Cunningham's skink, *E.cunninghami* and the White's skink, *E.whitii*. The observations are of captive lizards and indicate that the ingestion of sloughed skin in these species is intentional. A comparison of ecdysis is made with allied skink genera. The possible adaptive significance of this habit is discussed.

METHODS

A pair of *E.s.intermedia* have been in my care for more than eight years. During this period they were housed separately in two adjoining unheated indoor enclosures which received sunlight through a north facing window and were provided with fruit, tinned dog food and crickets (when available). A group of four *E.cunninghami* have been similarly maintained for the past six years, while *E.whitii* were maintained for a 12 month period only. All specimens were in excellent health during the periods of observation.

OBSERVATIONS

In all three species sloughing was generally initiated by the skin being worked loose along the head or flanks. Continued abrasion generally led to rows of adjacent scales forming folds of loose skin. The skin folds tended to form around areas such as the limb joints, axilla/inguinal regions and tail. Through continued abrasion, the skin folds tended to break-off in strips or 'rings'. It was also common for individual scales to be sloughed, particularly the strongly keeled tail scales of *E.cunninghami*. I describe below ecdysis as it typically occurred in adult *E.s.intermedia* based on 26 observations of ecdysis in the captive pair. Observations of a further four *E.s.intermedia* specimens suggest that the description below is fairly typical of the species.

During sloughing *E.s.intermedia* appeared restless and moved continually, rubbing themselves against abrasive surfaces such as rocks, logs and the gravel substrate of the enclosure. Their movements were confined to the small area of the enclosure where these objects were located and they performed repeated circuits of this area until most of the skin had been removed.

These movements were interrupted briefly to assist skin removal in other ways. In particular the removal of skin was frequently aided by using their teeth and pedes. The teeth were used to remove skin from the body, limbs and tail. In using teeth to remove skin from a rear limb, for instance, lizards assumed a curled-up posture. In this posture the head and anterior body were curled around towards the tail while the rear limb was lifted clear of the substrate and was outstretched, placing the pes within reach of the mouth. Loose and frayed skin was then grasped in the mouth and ripped away from the limb. Tail skin was removed similarly. Removing the skin from the manus and pedes was a rather delicate procedure and was achieved by lizards dragging the digits through their slightly opened mouths. In doing so they apparently used their teeth as a grate. This process resulted in the loose skin on the digits becoming frayed. The manus and pedes were typically dragged through the mouth several times before lizards continued to work the skin loose on other parts of their body. The process was repeated up to five times for each limb until the skin was capable of being peeled off with the teeth. The skin on the manus and pedes was in some instances removed as intact gloves but otherwise as torn fragments. The pedes were also used to loosen and abrade skin on the head and dorsum that apparently could not be reached by the mouth. The claws were used to scratch loose and fray the skin that was then removed by rubbing the body against abrasive surfaces or by the teeth. Loose rings of tail skin were easily removed using the teeth. The entire process of removing the skin was generally completed in 1-2 hours.

Sloughed skin was repeatedly consumed throughout the sloughing process. All pieces of skin removed using the teeth were immediately consumed. In addition, pieces of skin which had adhered to rocks and logs were first identified visually, and then by one or two tongue flickers, before being consumed. This behaviour occurred repeatedly during the lizards' efforts to loosen skin. At the completion of sloughing most of the remaining skin consisted of just single scales, all larger fragments having been eaten.

E.cunninghami was observed to have a similar behavioural repertoire, with all the behaviours described for *E.s.intermedia* having been observed in the species (based on 15 observations of sloughing). When the enclosure was cleaned, usually several days after sloughing had occurred, it was found that remarkably little sloughed skin remained. While most skin was consumed at the time of sloughing, individuals were sometimes observed consuming pieces of skin sloughed days earlier by other lizards. Most uneaten skin was found in parts of the enclosure inaccessible to lizards, having been inadvertently swept there by the lizards' general movements. Occasionally individuals were observed to remove and consume pieces of skin from lizards that were sloughing. As individual *E.s.intermedia* were kept separately it was not determined whether they also possessed this grooming behaviour. *E.whitii* were observed consuming pieces of freshly sloughed skin stuck to substrate material and using their teeth in a fashion similar to that described above to remove and consume sloughed skin from the limbs and tail.

DISCUSSION

The observations are similar to those of Barwick (1965) who observed *E.cunninghami* pulling off pieces of sloughed skin from the feet with its teeth and Hickman (1960) who observed *E.whitii* pulling skin from limbs with their teeth and found sloughed skin in the gut of neonates and adults. D.Goodwin (pers.comm.) observed a captive adult *E.striolata* pull the whole tail skin off in one piece and then eat it. He also noted an absence sloughed skin in the enclosure, suggesting that it had been consumed either by this lizard or its *E.s.intermedia* cagemates. By contrast Wells (1972) observed sloughing in an adult captive *E. S. intermedia* in which the skin was disgarded in large pieces and not consumed.

Ecdysis in *Egernia* species differs somewhat from that observed in the allied skink genera *Tiliqua* and *Hemisphaeriodon*. Unlike the

Egernia, Tiliqua species often shed skin in large pieces; in some cases the skin from head and body is shed in one piece and only rarely as single scales (Coleman 1944, Shea 1982, pers.obs.). I have occasionally observed captive *T.s.scincoides* and *T.nigrolutea* using their teeth to remove pieces of skin during sloughing but this skin was rarely consumed. P.Rankin (in Shea 1982) stated that *T.nigrolutea* and *T.rugosa* "sometimes" eat their sloughed skin. Edwards (1962) observed dermatophagy in *T.scincoides* and *T.gigas* but no details were given. Shea (1980) observed an individual *T.rugosa* remove a large portion of skin from the rear body and limbs using its mouth but the skin was not consumed. Captive *H.gerrardii* sometimes use their teeth to rasp the digits thereby removing or fraying skin, however the skin was rarely consumed (Turner *in press*).

The complete removal of sloughed skin using the teeth might be interpreted as beneficial to individuals since the failure to remove skin, for example from the digits (dysecdysis), can result in necrosis and their eventual loss (e.g. Hazell *et al* 1985). However, it is not clear why sloughed skin should then be consumed. I discuss some possible explanations for this.

Bustard & Maderson (1965) suggested that the habit of ingesting sloughed skin in squamates derives from the skin's nutritional value, it being a potential source of vitamin D and/or protein. In the three *Egernia* species examined little of the consumed skin appeared to be digested as was evidenced by its presence in faecal pellets. Faecal pellets from *E.cunninghami* populations inhabiting the Melbourne region contain various pieces of undigested sloughed skin (pers.obs.). Barwick (1965) also commented on the presence of undigested skin in alimentary tracts and scats *E.cunninghami* and suggested that the species may be incapable of digesting keratin. The *Egernia* as a whole appear to be quite broad in their feeding habits, ranging from species with a substantial plant component in their diet (e.g., *E.cunninghami*, Barwick 1965; *E.major*, Conran 1983) to those which subsist almost entirely on arthropods (e.g., *Egernia whitii*, Hickman 1960; also see Greer (1989) for a summary). There does not however appear to be any clear link between diet and the ingestion of sloughed skin in species of *Egernia* that might be expected if Bustard & Maderson's (1965) suggestion is true.

It is generally known that some squamates abstain from feeding in the lead-up to ecdysis, with it resuming after the process is completed. This occurs in the *Egernia* and *Tiliqua* species that I have maintained (also see Edwards 1962, Shea 1982). The possibility therefore exists that sloughed skin is consumed in response to, or in compensation for, this mild inanition. That dermatophagy does not extend to all species (see Table 1 in Weldon *et al.* 1993) may be a reflection of the differences in energetic costs associated with ecdysis. Although energy expenditure of ecdysis has been measured in *E.cunninghami*, where it was found to exceed that for reproduction (Shine 1971), there have been no similar studies of cogeners.

It is also possible that the ingestion of sloughed skin results from a 'hard-wiring' of the feeding response. That is, while the mouth is used to remove skin, it might be that once skin is in the mouth it is treated as food and so is consumed. However, the way in which *E.s.intermedia*, *E.cunninghami* and *E.whitii* manipulate food in their mouths before ingestion indicates that they are capable of excluding unpalatable material (above a certain size) which may have adhered to a food item. For example, *E.s.intermedia* are able to exclude pieces of gravel and leaf fragments from being ingested which have adhered to food. Therefore it would seem unlikely that individuals could consistently ingest pieces of sloughed skin if it was not considered acceptable 'food'. These observations indicate that the three *Egernia* species can discriminate between palatable and unpalatable items and would therefore seem to contradict the proposed explanation.

While it is natural to associate the ingestion of an item with feeding (i.e., nutriment gain), ingestion might also be used as a means of disposing of items that are not considered food.

Given that many species of *Egernia* have well defined home sites (i.e., utilise particular refuges) and that some species are gregarious, it may be that the ingestion of sloughed skin serves to prevent its accumulation around dwellings. This might benefit individuals by making home sites less conspicuous to certain predators or perhaps prevent disease.

ACKNOWLEDGMENTS

Thanks are due to Danny Goodwin for permitting me to include his observations, Rob Valentic and referees Darryl Houston and Glen Shea for their suggested improvements to the manuscript.

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OBSERVATIONS OF A NESTING OLIVE RIDLEY TURTLE IN THE NORTHERN TERRITORY.

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INTRODUCTION

The olive ridley turtle (*Lepidochelys olivacea*, Escscoltz 1829) has a pan-tropical distribution. It is a poorly known species in Australia, where there is little information available on feeding and nesting populations. The distribution of the feeding populations which has been obtained mainly from trawled or beach washed specimens, ranges from southern Queensland to Western Australia (Limpus 1975, Limpus *et al.* 1981, Harris 1994, Chatto and Guinea 1994). Limited surveys show that olive ridley nesting occurs from Cape York (Limpus and Roper 1977, Limpus *et al.* 1983) through to the Coburg Peninsula (Cogger and Lindner 1969, Guinea 1990, Limpus and Preece 1992). Additionally, there are two reports of nesting from Casuarina Beach in Darwin (R. Chatto pers. comm.) and one track reported from Native Point 80 km west of Darwin (M. Guinea pers. comm.). Because of the paucity of data for olive ridley turtles in Australia all observations need to be documented for future reference. Herein are reported the first measurements of an olive ridley nesting in the Northern Territory (the second for Australia), notes on egg chamber construction and a complete data set on egg size and weight, hatchling size and weight, scale counts, incubation time and nest success. This is the most westerly nesting record for this species in Australia.

METHODS AND STUDY SITE

Field work was conducted on Bare Sand Island (12o 32'.39 S 130o 25'.02 E), a sparsely vegetated permanent sand island, situated 70 km west of Darwin on the north east perimeter of Fog Bay. The western beach was patrolled for nesting turtles during 32 nights in April, May, June, July and August 1996.

Standard measurements of the adult, eggs and hatchlings were taken following the methodology of Limpus *et al.* (1983). Adult head measurements were taken using vernier calipers. Scale counts were conducted on hatchlings which were found alive in the nest. The scute terminology follows Marquez (1990). The width of the track was measured from the outer most disturbed sand. The nest dimensions were measured with a fibre glass tape after the eggs had been removed. Nest success was calculated as the number of hatchlings which emerged from the nest out of total number of eggs in the clutch. This comprised two components; hatching success and escape success (Horrocks and Scott 1991). Hatching success is the number of eggs which hatched from the total clutch and escape success is the number of these hatchlings which emerged from the nest. Eggs and hatchlings which remained in the nest after hatching were described as; undeveloped (no embryo visible), unhatched (embryo present), dead in nest (hatchling died after hatching) and alive in nest (hatched but did not emerge.)(see Limpus 1983).

RESULTS

On 19 May 1996 an olive ridley turtle sea turtle nested on the western beach of Bare Sand Island. No other nesting by this species occurred from April to July 1996. The beach was patrolled from night 11 to night 15 of the post nesting period but the olive ridley did not return to re-nest during this time and therefore a re-nesting interval could not be obtained.

The adult emerged from the sea at 2130 hours (three hours and fifteen minutes after high tide), successfully laid and re-entered the water at 2215 hours. The adult left a track 73-77 cm wide in dry sand and 80-85 cm wide in wet sand. The nest was laid in bare sand 20 cm vertically height above the high tide for the

night, yet 60 cm below the spring high water line. The eggs were measured and relocated to a site above the spring high tide mark.

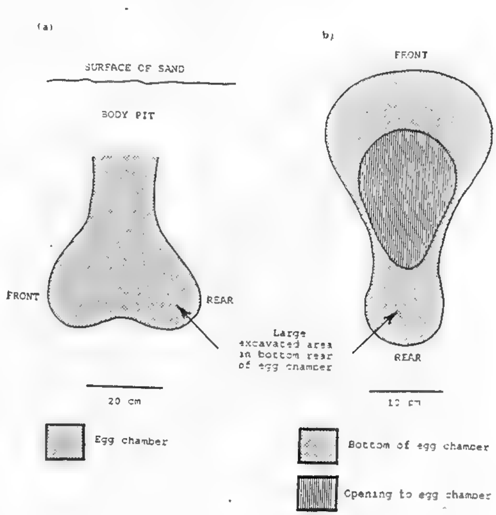
ADULT MEASUREMENTS

The adult measurements were; weight = 41.0 kg, curved carapace length (ccl) = 69.8 cm, curved carapace width (ccw)= 69.3 cm, plastron length = 55.9 cm, plastron width = 54.0, plastron to tip of tail = 14.0 cm, carapace to tip of tail = 1.0 cm, vent to tip of tail = 4.0 cm, skull width = 11.4 cm.

NESTING BEHAVIOUR AND NEST DIMENSIONS

The nest consisted of a shallow body pit that measured 25 cm from the surface of the sand to the top of the egg chamber. The mouth of the egg chamber was pear-shaped measuring 16.5 cm X 13.5 cm with the largest width at the front. The nest measured 46 cm from the surface to the bottom. The top-most egg was 35.0 cm from the surface of the sand. The floor of the egg chamber was uneven with a depression at the front and rear (Fig 1.). The turtle covered the nest using the hind flippers to position the sand over the clutch. It then proceeded to compact the sand by alternately raising each side of the body and slamming the plastron audibly down on the sand. This was repeated until the nest was covered.

Fig.1 Dimensions of the olive ridley nest on Bare Sand Island. (a) Profile view of nest. (b) Plan view of nest.



CLUTCH DATA

Sand temperature at 45 cm below the surface of the sand was 29.5 C at the time of oviposition. Clutch size was 108 eggs. The eggs were white and spherical with a mean diameter 3.81 cm (sd=0.07, min.=3.71, max.=3.91 n=10) and a mean weight of 29.5 g (sd=1.27, min.=28, max.=32, n=10).

Table 1. Scale counts of olive ridley hatchlings.

Scale counts indicate number of scales on left/right sides of the body followed in parentheses by the number of hatchlings with that count. PRC=pre central, CE=central, PC=post central, Co=costal, M=marginal, IF=infra marginal, IG=intergular, Po=post orbital, PRo=pre orbital, PF=pre frontal, PP=post parietal (s=symmetrical and a=asymmetrical).

PRC	CE	PC	Co	M	IF	IG	Po	PRo	PF	PP
1(6)	5(1)	2(6)	6/6(1)	12/12(4)	4/4(6)	1(4)	3/3(2)	0/0(6)	4(6)	2S(1)
	6(4)		7/7(3)	12/13(1)		2(2)	3/4(2)			2A(2)
	7(2)		7/6(1)	13/12(1)			4/4(1)			3S(1)
			6/8(1)				3/5(1)			3A(2)

INCUBATION PERIOD, HATCHING SUCCESS AND EMERGENCE SUCCESS

The nest hatched on 11 July, 53 days after the eggs were laid. The nest success was 79.6%, with hatching success being 82.4%, emergence success, 92.1%. There were no unhatched eggs, but 19 were undeveloped. Three dead hatchlings and four live hatchlings remained in the nest.

HATCHLING DATA

Mean straight carapace length and mean weight were 4.11 cm (sd=0.174, min.=3.82, max.=4.35, n=6) and 15.33 g (sd=0.943, min.=14.0, max.=17, n=6) respectively. Scales varied between individuals and are shown Table 1.

DISCUSSION

Bare Sand Island does not represent a significant breeding area for the olive ridley turtle but it may be indicative of low density nesting across many beaches in northern Australia. Unlike the mass nesting or "arribazon" behaviour of the olive ridley in other parts of the world (Marquez 1990), nesting in the Northern Territory appears to be very scattered, although there is some concentration of nesting around a number of core locations such as the Coburg Peninsula, McCluer Island group, N.W. Crocodile Island and Grant Island (Cogger and Lindner 1969, Guinea 1990, Limpus and Preece 1992). As the size of the feeding and nesting populations are unknown in Australia and substantial numbers have been killed through commercial fishing activities (Chatto and Guinea 1992, Harris 1994) it is important that more information is compiled on this species.

The narrow asymmetrical track of the olive ridley turtle (width=75 cm) makes it easy to distinguish from the larger symmetrical tracks of turtles such as the green (*Chelonia mydas*) and flatback (*Natator depressus*). Flatback turtles which nest on the same beach have a track width of approximately 95 cm. More observations on nest location are needed to substantiate the apparent preference for this species to nest after high water in bare sand in the mid beach zone.

The size and body weight of the adult olive ridley on Bare Sand was within the limits for this species in other countries (Marquez 1990) and of a similar size to the olive ridley which nested at Crab Island in north Queensland (Limpus *et al.* 1983).

The clutch count, egg and hatchling data are within the ranges of previous data from the Coburg Peninsula (Cogger and Lindner 1969, Guinea 1990) and Crab Island, North Queensland (Limpus *et al.* 1983) in Australia and within the ranges of data from outside Australia (Marquez 1990, Mohanty-Hejmadi 1992). Scale counts of the hatchlings are similar to those from other sites in the Northern Territory (Cogger and Lindner 1969, Guinea 1990).

The incubation time of 53 days is within the range for this species (Marquez 1990) and just one day more than times recorded previously in the Northern Territory (Cogger and Lindner 1969). Nest success was slightly higher than the 81% obtained from the Coburg Peninsula (Guinea 1990). This indicates that the relocation of the clutch did not have any adverse effects on either hatching or emergence success.

There is little comparative work done on nesting behaviour between species of sea turtles. The egg chamber of the olive ridley was different in shape to those of flatback turtles on the same beach because it had a large depression in the rear of the chamber. It was a similar depth to other olive ridley nests (Guinea 1990) but suprisingly deep when compared to the nests of the much larger flatback turtle. The unusual behaviour of using the body to compact the sand after oviposition is a behaviour not reported for other sea turtle species.

The feeding areas of olive ridley turtles which nest in Australia is unknown. A feeding area for adult sized olive ridley turtles (size range

62-88 cm ccl) exists in Fog Bay (M. Guinea unpublished manuscript) although there are no recaptures to indicate that these turtles nest in this area. The Fog Bay olive ridley turtles are presumably migratory as in other parts of the world (Marquez 1990). It is likely that the nesting turtle at Bare Sand Island had traveled from outside the immediate region.

The olive ridley which nested on Bare Sand Island represents one of the most westerly records of nesting for this species in Australia. The majority of olive ridley nesting in Australia occurs over 200 km north east of Darwin. It is difficult to determine the size and distribution of the olive ridley nesting population in Australia, until results of surveys in Queensland, Northern Territory and Western Australia are published.

ACKNOWLEDGMENTS

Michael Guinea provided helpful advise on the manuscript. Improvements were made to the manuscript by Colin Limpus and one anonymous reviewer.

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DIET AND REPRODUCTIVE STATUS OF A ROAD-KILL SPENCER'S MONITOR *VARANUS SPENCERI.*

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INTRODUCTION

Spencer's monitor, *Varanus spenceri*, is a moderately large robust monitor lizard endemic to the black-soil plains of western QLD and central-eastern NT (Dale 1973, Wilson & Knowles 1988, Ehmann 1992). Relatively little has been published on the natural history of this species since its original description by Lucas & Frost in 1903 (e.g., Dale 1973, Green & King 1993). Pengilley (1981) provided details on the species' diet and reproduction (timing and clutch size) based on the dissection of specimens from the Barkly Tableland region, NT. Ehmann (1992) provided notes on the species habits and diet. other than these works the remainder of the published material is mostly anectdotal or derives from captive lizards and includes the successful captive breeding of the species (Peters 1968, 1969ab, 1971, 1986 see also Christian 1979). In this note we provide additional details on diet and reproduction through the dissection of a single road-kill *V.spenceri*.

OBSERVATIONS

At approximately 1530hrs (CST) on 18 october 1996 a severely injured adult *V.spenceri* was observed lying upturned on the Barkly Hwy (137°42'E, 20°01'S), 32km west of the NT-QLD border (and 45km west of Camooweal (138°06'E, 19°55'S), QLD). Weather was overcast with heavy cloud cover, a gentle south-easterly breeze and light rain. Air temperature was 24.0°C and relative humidity 60%. The area had evidently received rain during the last few days though there was no standing water. Habitat consisted of 'black'-soil grassland plain, lacking middle and upper vegetation layers. The ground layer consisted of well-spaced Mitchell grass (*Astrebla* spp.) tussocks separated by patches of exposed brown friable soil with numerous cavities.

On closer inspection of the lizard it was found to be still alive. It was observed to exhibit gular pumping and periodic gaping of the mouth as though trying to regorge. As both rear limbs were broken along with the pelvis, it was thus decided to euthanase the lizard. Dissection confirmed that the specimen had been hit in the pelvic region. The pelvis was broken in two as were the tibia and fibula of the right rear limb, the tibia of the left rear limb, and there was extensive internal bleeding in the pelvic region.

The lizard's dimensions were as follows: snout-to-vent length (SVL) 435mm, tail length (TL) 445mm, head length (HL; as measured from the tip of the rostral scale to the anterior edge of the tympanum) 58.7mm and head width (HW; measured at the mid-tympanum level) 34mm.

Upon dissection the specimen was found to be a gravid female, with 13 late stage shelled eggs filling much of the abdominal cavity. (see Figure 1.) The 13 eggs, three of which had evidently burst when the lizard was hit, were removed from the oviducts (7 in left, 6 in right). All egg shells were clean, white and turgid and tended to collapse slightly under their weight when placed on a flat surface. Egg dimensions and weights are given in Table 1. Egg albumen was uniform lemon yellow in colour with no visible embryo. This is apparently the case for viable eggs at the time of deposition (G.Fyfe, pers.comm.).

Several clearly identifiable prey items were present in the gut. Two adult *Ctenotus joanae* (#1 SVL=76mm, TL=117mm, 26mm was regenerated and some 10mm was missing; #2 SVL=79mm, TL=138mm, 47mm regenerated). The head of specimen #1 was crushed and there were clear bite marks on the neck and mid-body region and isolated tooth punctures on the ventral surface. Specimen #2 appeared

to have been consumed earlier than #1 and was partly eviscerated. Two small iridescent green beetles (each 8mm long) were amongst the viscera and were probably consumed by #2. A very recently ingested adult male *Tympanocryptis tetraporophora* (SVL=59mm, TL=100mm, sex confirmed by everting hemipenes) was also found lodged in the throat of the specimen and showed no externally visible bite marks or injuries. None of these prey items were chewed. In addition to these items a large roach (blattodea, approx. 30mm long, too large to have been secondarily ingested) was identified from intact abdominal segments and was observed to be common beneath ground debris on the plain where the lizard was taken.

The presence of external and internal parasites was noted. Two clusters, each of 12 ticks, occurred just below the pectoral region of the ventral surface and about 15mm past the vent on the underside of the tail. A number of small live transparent nematode worms (20-25mm in length) were located inside the oesophagus, on the *T.tetraporophora* and the *C.joanae* prey items and in the gut.

DISCUSSION

V.spenceri feed on a broad range of prey items, which is typical of the larger varanids (Losos & Green 1988, King & Green 1993). Pengilley (1981) records *V.spenceri* as feeding on isopods, orthopterans (grasshoppers), unidentified mammals ('probably *Rattus villosissimus*'), and reptiles, with single records of an unidentified agamid and an elapid snake, *Pseudonaja ingrami*. Wilson & Knowles (1988, p.360) state that the species feeds on a variety of small vertebrates, arthropods and carrion. Ehmann (1992, p.156) states 'Adults hunt lizards, snakes, large insects and small mammals' and juveniles as eating 'isopods (which abound in the soil crevices they frequent), small geckos and skinks'.

The prey items we recovered have not been previously identified in the diet of *V.spenceri*. Both *C.joanae* and *T.tetraporophora* are relatively small fast diurnal species, while *V.spenceri* is noted as not being particularly agile (Christian 1979), not surprising given its robust build. This may suggest that the lizards were detected in, and extracted from, refugia rather than being preyed on when surface active. This mode of foraging is known to occur in varanids (Green & King 1993, p.14, Valentic 1994). As the female was heavily gravid it would be expected that her movements were more restricted, lending support to the suggestion.

Green & King (1993, p.32) noted that in *V.tristis* and *V.scalaris* most gravid females carrying 'nearly developed eggs' had empty stomachs and suggested that this was due to the limited space and pressure created by eggs on other internal organs. It is therefore notable that even though heavily gravid the road-kill *V.spenceri* had recently been feeding. G.Fyfe (pers.comm.) has noted that in captivity gravid females of the species only cease feeding about one week before ovipositing.

Pengilley (1981) recorded that all specimens ($n \geq 14$) collected from late September to early october were gravid, or had very recently oviposited, and that the clutch size varied from 11 to 31 (n=13); this is consistent with our observation. observations on captive specimens (Peters 1969ab, 1971, Christian 1979) broadly agree with the timing of reproduction in temperate zone species in James *et al.* (1992). Pengilley also gave the dimensions of five recently laid eggs: average length 47.8mm (range 47.3-49.6mm) and average width 30.6mm (range 30.0-31.0mm) which are quite close to the egg dimensions in Table 1 suggesting that the latter were close to full term. The size of the specimen we examined is within the size range of ovigerous females found by Pengilley (1981).

ACKNOWLEDGEMENTS

We thank Greg Fyfe for providing us with information on his captive breeding of *V.spenceri*, Ray Hoser for providing us with several references and the referees, for their helpful comments and improvements to the manuscript.

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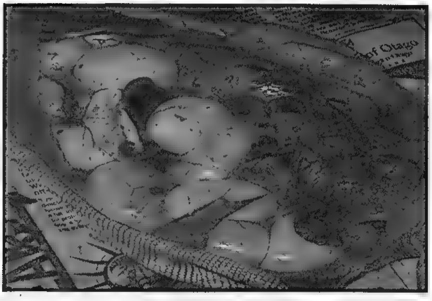
Table 1. ***Varanus spenceri*** **egg dimensions (n=10).**

LENGTH (mm)	WIDTH (mm)	MASS (g)
45	30	12
45	30	19
45	29	20
42	30	13
42	29	13
40	27	20
45	30	21
44	30	18
41	30	18
40	30	18
AVE.42.9	**29.5**	**17.2**

Figure 1. Dissected *Varanus spenceri* showing the eggs and distended stomach



SURVEY OF THE HERPETOFAUNA OF THE BOMADERRY CREEK URBAN BUSHLAND AT NOWRA, NSW.

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ABSTRACT

A study of the herpetofauna in the Bomaderry Creek Bushland, an area of urban bushland on the south coast of NSW, identified 10 species of frogs and 19 species of reptiles. Threats to the long-term survival of this rich herpetofauna are discussed.

INTRODUCTION

Bomaderry Creek Bushland (150o35'E, 34o51'S) is located between the urban areas of Bomaderry and North Nowra at Nowra on the south coast of NSW, 120 kilometres south of Sydney. The Bushland area includes Crown land, Council-owned land and freehold land and is approximately 230 hectares in area (Barratt 1994).

The substratum is Nowra Sandstone which has been deeply eroded by Bomaderry Creek. The elevation ranges from 0 to 60m AHD. The vegetation includes woodland dominated by Scribbly Gum *Eucalyptus sclerophylla* and Red Bloodwood *Corymbia gummifera*, open forest dominated by Spotted Gum *Corymbia maculata* and Grey Gum *Eucalyptus punctata*, wet heath and sedgeland in poorly drained areas, and warm temperate rainforest along the Bomaderry Creek gorge.

METHODS

observations of the reptiles and amphibians occurring in Bomaderry Creek Bushland were made opportunistically between 1993 and 1995. Field work was conducted in all seasons and included direct observation of diurnally active animals, active searching by lifting rocks, logs and rubbish, spotlighting at night with a 50 watt spotlight and listening for frog calls.

Species were assigned to one of three categories for abundance. Rare species were those recorded only once during the survey, uncommon species were recorded up to five times, and common species were recorded six or more times.

RESULTS

Nine species of frogs and 15 species of reptiles were recorded by the author during the survey. An additional five species (one frog and four reptiles) have been documented by Barratt (1994). Table 1 provides a summary of the 29 species recorded in the study area. Taxonomic nomenclature in this paper follows Cogger (1992).

DISCUSSION

The Bomaderry Creek urban bushland area supports a diverse range of reptiles and amphibians. This is a reflection of the range of microhabitats provided by the different vegetation types, the creek, and the abundant rock outcrops. Murphy (1994) noted that it was one of the richest sites in the Nowra area on a species per hectare basis. Subsequent work by Murphy and Daly (in press) has supported this.

A number of species recorded in the study area are of conservation significance. *Heleioporus australiacus* is listed as vulnerable in the NSW *Threatened Species Conservation Act 1995*. *Pseudophryne bibronii* is apparently declining in NSW and is of conservation concern (Osborne 1990; Mahony 1993; Ehmann 1997). A number of species, including *Litoria caerulea, Oedura lesueurii, Cryptoblepharus virgatus, Pseudemoia platynota* and *Ramphotyphlops nigrescens*, are locally uncommon.

The record of *Demansia psammophis* is well outside the range of the species in NSW as documented by Swan (1990). There was a specimen in the Australian Museum from Nowra in 1935 which is no longer in existence (Sadlier, pers. comm.). A specimen obtained by the author in the Bomaderry urban area has been lodged in the Australian Museum (AM specimen R147407 and now represents the southern-most specimen-based record of this species in coastal NSW.

The Bomaderry Creek Bushland faces a range of pressures typical of urban bushland remnants in general. The most publicised has been a proposal for a link road crossing the bushland which was the subject of a Land and Environment Court case. other pressures include reduction in area through further urban development, infiltration by exotic weeds, reduced water quality, bush rock collection, altered fire regime, predation of wildlife by domestic cats and dogs, and wildlife fatality on surrounding roads.

The final result of these pressures on isolated urban bushland remnants is a decline in species diversity over time through local extinctions. This process has not yet significantly impacted on the Bomaderry Creek Bushland herpetofauna. However, comparison with the herpetofauna of an older, smaller and more degraded bushland remnant, such as the Gore Creek bushland remnant in inner suburban Sydney (Murphy 1996), indicates the extreme reduction in species diversity which could potentially occur.

At present the Bomaderry Creek Bushland retains a rich and varied vertebrate fauna. Consideration and long term management of urban bushland pressures will be necessary if this diversity is to be conserved.

ACKNOWLEDGEMENTS

Thanks to Sam Murphy for company and assistance in the field, and Ross Sadlier and an anonymous referee for reviewing an earlier draft of the manuscript.

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Table 1

Species recorded in Bomaderry Creek Bushland

Key:

Method of detection: D = Diurnal observation, A = active searching, S = spotlighting, C = listening for calls. Habitat: W = woodland, o = open forest, R = warm temperate forest, H = wet heath and sedgeland, A = aquatic. Status: R = rare, U = uncommon, C = common.

	Method				Habitat					Status
	D	A	S	C	W	O	R	H	A	
AMPHIBIA										
HYLIDAE										
Green Tree Frog *Litoria caerulea*			x		x					U
Bleating Tree Frog *Litoria dentata*			x	x	x			x		C
Lesueur's Frog *Litoria lesueuri*			x			x	x			U
Peron's Tree Frog *Litoria peronii*			x	x				x	x	U
Leaf Green Tree Frog *Litoria phyllochroa*	x		x	x			x		x	C
Myobatrachidae										
Common Froglet *Crinia signifera*			x	x	x			x		C
Giant Burrowing Frog *Heleioporus australiacus* [1,2]								x		-
Brown-striped Frog *Limnodynastes peronii*				x		x				R
Bibron's Toadlet *Pseudophryne bibronii*		x		x				x		U
Tyler's Toadlet *Uperoleia tyleri*			x					x		R
REPTILIA										
Chelidae										
Eastern Snake-necked Turtle *Chelodina longicollis*	x								x	R
Gekkonidae										
Lesueur's Gecko *Oedura lesueurii*		x	x			x				U
Agamidae										
Jacky Lizard *Amphibolurus muricatus*	x					x		x		U
Gippsland Water Dragon *Physignathus lesueurii howittii*	x					x	x		x	C
Varanidae										
Lace Monitor *Varanus varius*	x					x				U
Scinidae										
Fence Skink *Cryptoblepharus virgatus*	x					x				U
Copper-tailed Skink *Ctenotus taeniolatus*	x	x				x		x		C
Eastern Water Skink *Eulamprus quoyii*	x					x	x			C
Grass Skink *Lampropholis delicata*	x				x	x				C
Red-throated Skink *Pseudemoia platynota*		x				x				R
Weasel Skink *Saproscincus mustelinus*	x					x	x			U
Eastern Bluetongue *Tiliqua scincoides*	x					x		x		C
Typhlopidae										
Blind Snake *Ramphotyphlops nigrescens* [3]		x				x				U
Boidae										
Diamond Python *Morelia spilota spilota* [2]							x			-
Elapidae										
Golden-crowned Snake *Cacophis squamulosus* [2]						x				-
Yellow-faced Whipsnake *Demansia psammophis*	x	x				x				C
Eastern Tiger Snake *Notechis scutatus* [2]						x				-
Red-bellied Black Snake *Pseudechis porphyriacus* [2]								x		-
Eastern Small-eyed Snake *Rhinoplocephalus nigrescens*		x			x					R
Total	12	7	8	6	5	17	6	10	4	

[1] vulnerable species in NSW *Threatened Species Conservation Act 1995*

[2] species documented by Barrat (1994)

[3] two voucher specimens lodged with the Australian Museum (R151352 and R151353)

LOW VOLUNTARY MINIMUM TEMPERATURE FOR ACTIVITY IN AN ALPINE GECKO FROM NEW ZEALAND

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This note was prompted in reply to Porter (1997) who discussed cold-tolerant activity in lizards, with particular reference to Australian Gekkonidae. Several species from Australia and New Zealand (including *Lucasium damaeum* and *Hoplodactylus maculatus*) were reported to remain active at temperatures as low as about 8°C, but in general few reports existed for lizards active below 15°C. The chameleon *Chameleo namaquensis* was reported by Burrage (1973) to capture prey at 3.5°C.

Several reports from New Zealand record gecko activity at very low temperatures. Thomas (1981) reported *H.rakiurae* (an alpine-subalpine species) active at 4.5°C, and Whitaker (1984) reported *H.kahutarae* (an alpine species) to forage at 6.5°C. The authors observations of several members of the *H.maculatus* species-complex from the South Island indicate that these geckos too will remain sporadically active down to 4.5°C, but that activity ceases below this point.

The Takitimu gecko (*Hoplodactylus* sp.) is a newly discovered species from the Takitimu Mountains, Southland (South Island, New Zealand). The only known specimen was taken live from alpine scree with surrounding herb-fields and short tussocks at 1140m alt. (well above the tree line) in March 1996. It was maintained alive in captivity for five months, where many behavioural observations were made. It was active day and night, living among rock piles and low, dense scrub.

Temperatures were recorded regularly with a standard alcohol thermometer (calibrate checked with a second thermometer of similar design) in an attempt to discover the minimum and maximum temperatures in which this and other species would forage. Air temperatures were taken inside the enclosure, within 5-10cm of the lizard.

The gecko was commonly active at air temperatures of 5-6°C or more, occasionally appearing down to about 4°C. The lowest temperature in which it was observed to leave its retreat and move about in the open was an astounding 2.8 °C! In this instance the enclosure was indoors due to heavy frosting outside. The observation was made at 11.40am, there had been no basking opportunity for several days and with repeated frosting over the past few nights the cage (unheated) had not risen above about 4-5°C for more than 24 hours.

Unless there are records I am unaware of, this is the lowest temperature at which any lizard has been recorded in uninduced activity, and is a substantially lower temperature than that which the vast majority of reptiles will tolerate. Gill and Whitaker (1996) implied that 6°C was the lowest temperature at which any lizard was known to forage, however the present observations and those of Thomas (1981) clearly reduce this minimum by several degrees. While several geckos will respond and move in lower (even zero) temperatures if provoked (including some *Hoplodactylus* and, to a lesser degree of mobility, *Naultinus* species, pers.obs.) it is significant that the Takitimu gecko chose to move about in 2.8°C and it had not been disturbed in any way.

The area in which the gecko was discovered frequently experiences cold conditions, may receive temporary snow cover at any time of the year, and is snow-bound for several months over winter. Although little is known about the species, it is clear that the Takitimu gecko is highly adapted to cold temperature activity, perhaps more so than any other reptile.

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A FURTHER INSTANCE OF TONGUE REGENERATION IN A SNAKE

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I was interested and delighted to read the article in Herpetofauna 26(2) by Robert Valentic on tongue regeneration in *Aspidites*. In that article the author mentioned that he could find little written on the subject so I thought I would write as it reminded me of a similar situation I had in Bougainville Island, PNG in 1969.

I was working at the mine construction site on Bougainville and was brought a rather damaged Brown tree snake, *Boiga irregularis*, that had been given the usual kind of treatment that people nervous of snakes often dish out. Both its tongue tips appeared to have been battered and subsequently shrivelled and dropped off, leaving only the unbranched proximal part.

As far as I can remember, it was about four months later that I noticed both tongue tips had regrown fully, appearing to be totally normal.

On the rare occasion when I've remembered this over the intervening 28 years, it seemed so unlikely that it should happen that I had begun to doubt my memory, consequently I was delighted to read the account of a similar occurrence in *Aspidites*.

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INTESTINAL DIVERTICULUM IN A JUNGLE PYTHON (*MORELIA SPILOTA CHEYNEI*)

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On the 14th February 1996, a ten year old male Jungle Python, *Morelia spilota cheynei*, was presented with a large intracoelomic swelling. The swelling had developed over a period of one month. The snake was feeding regularly though passing only small amounts of pasty faeces.

Physical examination revealed a healthy, alert, 1.8 kg python with a large fluctuant swelling causing localised distention of the caudal coelomic cavity.

Radiographic examination of the affected area showed a dense faecal ball surrounded by a well-delineated gas accumulation.

On the 28th February liquid paraffin was administered in two killed adult mice. A small amount of faeces was subsequently passed. There was no change in the size or location of the intracoelomic distention.

On 17th April, the snake was sedated with Ketamine, at 55.5 mg/kg then intubated and anaesthetised with Isoflurane. Hartmann's solution (40 mls subcutaneously) and Baytril (10 mg/kg by intramuscular injection) were given pre-operatively.

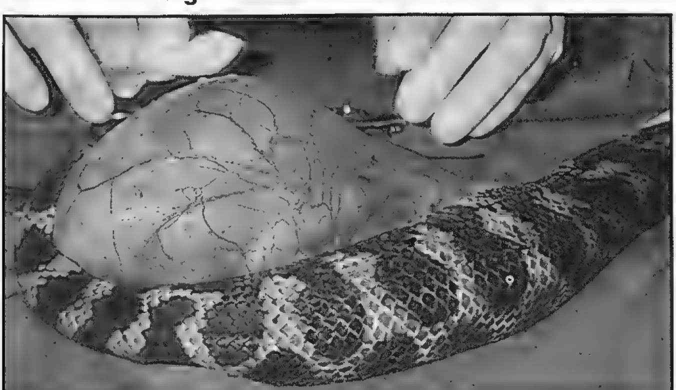
A longitudinal incision was made between the first and second row of scales lateral to the ventral scutes at the level of the distention. Coeliotomy revealed an intestinal diverticulum 19 cm in length and 7 cm in width, full of faecal material and gas. (See Figure 1). The diverticulum was resected and the intestinal incision sutured with a synthetic, monofilament, nonabsorbable material (PDS) in a simple interrupted pattern.

The coelomic cavity was flushed with warm Hartmann's solution. Peritoneum and muscle layers were closed with simple continuous synthetic absorbable sutures (Dexon). Skin closure was performed with nylon horizontal mattress sutures, and the surgical wound was then covered with Op-site dressings.

Baytril was given by intramuscular injection at 10 mg/kg for 4 days post-operatively then at 6.6 mg/kg for a further 6 days.

Recovery was uneventful and feeding recommenced 16 days post-operatively.

Figure 1. Intestinal diverticulum



DEFENSIVE BEHAVIOUR IN THE DEATH ADDER *ACANTHOPHIS PRAELONGUS*

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Body and tail movements have many functions in reptiles. Caudal movements are used by snakes such as death adders (Chizar *et al* 1990,) and pit vipers to lure prey (Greene and Campbell, 1972). Tail movements can be effective antipredatory behaviours in rattlesnakes (Brock Fenton and Licht, 1990) and some lizards (e.g. *Anolis cristatellus,* Leal and Rodriguez-Robles, 1995). Body and tail movements may also be applied during social interactions (Leal and Rodriguez-Robles, 1995).

One movement reported from only one species of reptile (the lizard *Anolis cristatellus*) is body thrashing (Leal and Rodriguez-Robles, 1995). This was described during artificially induced encounters between the lizard and its natural predator, a colubrid snake, and was interpreted as an antipredatory behaviour. The rattling of the tail structures in rattlesnakes is also a defensive behaviour but is not used as a first line defense against a predator (Brock Fenton and Licht, 1990). Rattling is activated when a potential predator is nearby and may step on and damage the snake.

Recently I observed a death adder (*Acanthophis praelongus*) body thrashing in the tropical woodland of the Northern Territory. The observation was made at 23.00 on a still, dry season night with a three quarter moon shining. I was walking through the bush stepping on sand to minimise noise (but not vibrations) when I stopped for no particular reason. A few seconds later, at a distance of three metres away a loud rustling of dry leaves on the ground alerted my attention. Nothing could be seen with a spotlight so I turned the light away and remained waiting. Approximately every 40 seconds the noise recurred for four subsequent bouts. After investigating more closely by moving leaves in the area with a stick, a brightly coloured, adult (approx. 35cm long) death adder was seen thrashing its whole body from right to left amongst the leaf litter. No other animals were found within a 3 metre radius of the adder and as I moved beyond this region, the thrashing movement ceased.

The noise made by the snake's action had alerted me to its presence. This defensive behaviour may have evolved in response to the high number of large mammals species which inhabit open woodlands. These species include wallabies and wallaroos, with the Common Wallaroo (*Macropus robustus*) weighing up to 49kg (Jarman, 1989). A death adder could easily be killed or injured if one of these heavy mammals landed on its head or body. Because death adders are sit-and-wait predators, these snakes may be reluctant to move from a good ambush site. Thus, body thrashing may have evolved instead of the usual defence mechanisms (fleeing) seen in most other species of snakes.

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THE PRESENCE OF THE COMMON SCALY FOOT, *PYGOPUS LEPIDOPODUS* ON THE MORNINGTON PENINSULA, VICTORIA.

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Pygopus is represented in Victoria by both the Common scaly foot *Pygopus lepidopodus* and the Hooded scaly foot *Pygopus nigreceps*. Both species occur from the mid-north of the state (*nigriceps*) into the north west (*lepidopodus*). While *P.lepidopodus* occurs in a variety of habitats in Australia, it is usually associated with semi-arid, inland mallee, and coastal heathlands. Victoria is no exception, with records both from mallee and to a lesser degree, from coastal heathland.

The National Museum of Victoria has a single specimen, collected pre 1900 from the Frankson area (38°10'S, 145°10'E) with other specimens from the Mornington Peninsula (38°15'S, 145°10'E) and East Gippsland (Larwill, 1995). These older records were considered by Museum staff to be possibly in error until recently when more specimens from the Mornington Peninsula were lodged with the Museum.

Pitfall trapping in the same area produced another three specimens (J. Coventry, pers. comm.). The specimens were collected from a granite based, clifftop habitat, with ddark soil and covered in low vegetation. In December 1995, a desiccated specimen of a 'legless lizard' was given to me for identification. It was a large *P.lepidopodus* measuring about 120 mm snout to vent but missing the tail. It had been collected beside a cliff track on ferruginous sandstone covered in low vegetation. This specimen was found approximately 10 kilometres south west of the pitfall sites. (See Figure 1). It was lodged with the National Museum of Victoria in January 1996.

It is estimated that only about 13% of the original vegetation remains on the Mornington Peninsula. Many animals and plants have become extinct in the region (Dunn et al, 1990). Whether *P.lepidopodus* is widespread or restricted to coastal areas is unclear. The remaining population may be afforded some protectin by their mostly inaccessible clifftop habitat.

ACKNOWLEDGEMENTS

Mr Peter Swan who provided the 'legless lizard' for identification.

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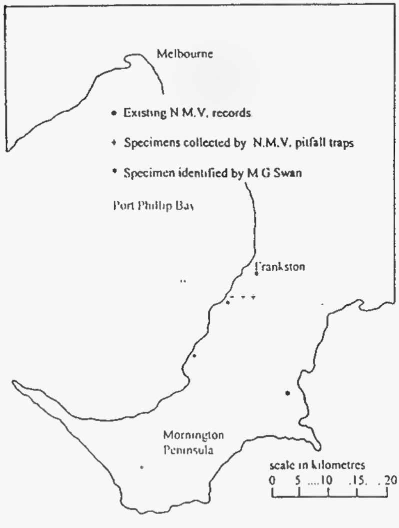
Figure 1 Mornington Peninsula, Victoria, showing localities for *Pygopus lepidopodus*



COMMUNAL EGG LAYING BY TWO SPECIES OF GEHYRA IN THE SAME SITE

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ABSTRACT

Eggs from two sympatric species of *Gehyra* were located under a large cement brick in a suburban backyard in Alice Springs, Northern Territory. Communal laying by *G.variegata* has been recorded by Bustard (1968) and from this work alluded to in Greer (1989). Communal laying is also recorded for *Gehyra* in general by Ehmann (1992). This paper records the first observation of more than one species of *Gehyra* utilising the same site for oviposition.

INTRODUCTION

Gehyra variegata and *Gehyra montium* are found in sympatry in many areas of suburban Alice Springs particularly in the vicinity of rocky hills (pers. obs.). In the natural areas of habitat on these hills *G.montium* is found exclusively amongst rocks while *G.variegata* may be found in both arboreal and terrestrial shelter sites including amongst and under rocks (pers. obs.). Away from these hills *G.montium* may also be located under shelter sites provided by humans such as bricks, rockeries and piles of timber. This occurs in areas at least 100m distant from the nearest natural rocky hill (pers. obs.).

G.variegata and *G.montium* appear to compete for resources in some situations as both species have been recorded foraging over the same large rock surfaces on hills in Alice Springs (pers. obs.).

OBSERVATIONS

on January 25, 1995 I found 26 gecko eggs in a suburban yard in Alice Springs under a large cement brick (40cm x 20cm x 10cm) at the base of a pile of timber. The stacked timber was about 2m long, 1m wide and 1m high. The brick was lying on one of its largest faces on a rough cement slab. A layer of fine decaying organic matter had built up beneath the brick. The eggs were spaced a centimetre or two apart and were located toward one end of the brick.

18 of these eggs had already hatched and the other 8 were removed from the site and placed in a container in order to determine their identity. The 18 eggs hatched showed various degrees of discolouration and staining and some of these may have been from the previous season.

While dismantling the pile of timber I observed adults of both *G.variegata* and *G.montium* utilising the pile as a homesite. The yard backs onto a reserve containing rocky hills approximately 50m away that extend into the large Telegraph Station Reserve.

RESULTS

Between January 27 and March 13 all 8 eggs hatched. Presented in Table 1 are the respective species of hatchling from each egg and their measurements.

Table 1

Date hatched	Species	Snout-vent length (mm)	Tail length (mm)
27/1/95	*G.variegata*	24	22
31/1/95	*G.montium*	25	23
13/2/95	*G.montium*	23	21
14/2/95	*G.montium*	23	21
21/2/95	*G.variegata*	25	23
24/2/95	*G.montium*	23	21
06/3/95	*G.montium*	26	22
13/3/95	*G.montium*	24	23

DISCUSSION

The apparent success rate of eggs hatching under the brick indicates an ideal site for oviposition. A similar ideal site in the lizards' natural habitat could also attract lizards from these two species to nest communally. Both species are abundant in rocky hill areas but preferred nesting sites may not be common enough for individual lizards to utilise their own site or even for each species to nest only with their conspecifics. The use of a common site for oviposition by these two species at an unnatural site may be a reflection of what also occurs naturally.

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A NOTE ON THE FORAGING BEHAVIOUR OF THE SNAKE *DENDRELAPHIS PUNCTULATA* IN THE NORTHERN TERRITORY

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Tree snakes of the genus *Dendrelaphis* are arboreal colubrids found in Australia, New Guinea, and Indo-Malaysia (Cogger, 1992). Of the two Australian species, the Common tree snake (*Dendrelaphis punctulata*) is the most widespread, occurring in coastal and adjacent areas of northern and eastern Australia. The ecology of *D. punctulata* is poorly known, despite it being a relatively common snake. The only quantitative study is that of Shine (1991), who examined diet and reproduction in Australian colubrids. Shine (1991) noted two things for *D. punctulata:* (1) strong geographic variation in diet, and (2) an ontogenetic dietary shift from lizards to frogs. In this note we describe the peculiar foraging behaviour of an individual *D. punctulata* at the Daly River near Oolloo Crossing (13°85'N, 131°36'E), Northern Territory.

At around 1000hrs on 3 October 1996 on a sunny day (maximum air temp = 40°C) we noticed a *D. punctulata* moving swiftly down the river bank in pursuit of a Rainbow skink (later identified as *Carlia gracilis*). Although we stood only about three metres from the snake it apparently did not notice us, as it began showing the following distinctive behaviours in an attempt to capture the skink, which had sought refuge in a patch (ca. 1m^2) of leaf litter.

(1) *Head probing/spearing.* The snake continually probed the leaves in two ways. First, it speared its head into the leaves, quickly retracting its head into a high position (see 2). Second, the snake probed the leaves in a slower fashion, occasionally deliberately flipping leaves sideways or forward with its head. Each probe or series of probes was immediately followed by a raising of the head and neck (see 2).

(2) *Raising the head and neck.* Immediately following (1) and during (3) and (4) below, the snake would raise its head ca. 20 cm above the ground and the head was invariably perfectly still, though the neck was often moving (see 3). The behaviour appeared to allow the snake to view the area around the patch of leaves should the skink be flushed out. The snake did this throughout the foraging bout.

(3) *Lateral neck movements.* Occasionally the

snake would sway its neck from side to side (but while keeping the head perfectly still), apparently in an attempt to flush out the skink. The neck moved in a wave-like fashion up to five cm laterally. The behaviour was sometimes exhibited in tandem with body undulations (see 4).

(4) *Body undulations.* Here the snake would undulate its body laterally, shifting its coils in the leaves, again apparently in an attempt to flush out the skink. As with lateral neck movements, the head remained high and still when this behaviour was noted.

These behaviours were exhibited in a seemingly random order, often in tandem with one another. In all cases the snake held its head perfectly still, and in a relatively high position. After about 8-10 minutes, the snake gave up on the skink, and began moving up the bank, where we captured it. The snake was a female (SVL = 105.6cm, TL = 40.2cm, mass = 144.3g), and was palpated and found to have 8 eggs. The skink was found beneath the leaves just after the snake was captured.

Shine (1991) reported *Dendrelaphis punctulata* to feed on frogs and lizards (one mammal and one insect were also found), but reported only frogs in individuals from the Northern Territory. While most (ca. 25) individual *D. punctulata* we observed near Oolloo Crossing were in *Pandanus* bushes, which harbored large numbers of frogs (especially *Litoria bicolor*), the behaviour we observed appeared to be specific for flushing out skinks. We doubt such behaviour would be utilised in catching frogs, because frogs seldom hide under leaf litter while being chased (pers. obs.), and frogs are generally inactive during the day when tree snakes are active (Shine, 1991). Shine (pers. comm.) has observed similar behaviour in captive *D. punctulata*.

The foraging individual was an adult female, indicating that while an ontogenetic shift in diet from lizards to frogs in *D. punctulata* may exist (Shine, 1991), at least some skinks are taken by adults in the NT. Shine (1991) suggested that prey choice in *D. punctulata* was flexible, and may be an important advantage for a colonising species, allowing it to take advantage of locally abundant prey types. We should note that both frogs and Rainbow skinks (*C. gracilis* and *C. amax*) are extremely abundant along the Daly River, even in the dry season. Whether or not the foraging behaviour we observed applies to the species as a whole, or whether the behaviour evolved locally cannot be determined without further investigation. Further foraging observations, complemented with dietary information (particularly throughout the range, and for a range of size classes) might infer the prevalence of the observed foraging behaviour in *D. punctulata*.

ACKNOWLEDGEMENTS

Thanks to R. Shine and W. Osborne for helpful comments.

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NOTES ON AN UNUSUAL COLOUR FEATURE AND REPRODUCTION IN THE DRAGON LIZARD *RANKINIA ADELAIDENSIS ADELAIDENSIS*

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On 6 October 1996 two *Rankinia adelaidensis adelaidensis* (Western Australian Museum R 129830-129831 = Australian Museum field numbers 45400-45401) were collected at Wanneroo, WA by G. Shea and M. Peterson. When the specimens were examined closely in early November just after being euthanased, both were noted to have small bright lemon yellow patches in the scaly corners of the mouth. These yellow patches were just barely evident when the mouth was closed but were fully exposed when the mouth was opened. With the mouth open, the yellow colour was highlighted by the pale blue colour of the posterior mouth area and the dark purplish black colour of the throat. Three months after preservation, these yellow patches were not visible. We have not encountered a description of this small but striking colour patch anywhere in the literature.

The function of the yellow patch at the corner of the mouth in this species is not clear. However, it is tempting to speculate that the colour serves as a signal to conspecifics. Furthermore, because the signal is small and under behavioural control (when the animal opens its mouth), it is probably a signal reserved for special circumstances such as an interaction with another individual at close quarters. Close observation of the behaviour interactions of captive individuals may help resolve the patch's biological significance.

Whatever its functional significance may be, the yellow mouth patch may have some taxonomic significance because it appears to be absent in the closely related *Rankinia adelaidensis chapmani* (based on observations on three males measuring 34-43 mm SVL and one gravid female measuring 46 mm SVL collected in early November 1989, see Greer *et al.*, 1991).

Both specimens are ovigerous females. One specimen measured 49 mm SVL, weighed 3.66 g, and carried one yolking follicle in the left ovary and two in the right. The other specimen measured 51 mm SVL (preserved), wieghed 4.77 g (fresh intact), and carried two yolking follicles in the left ovary and three in the right. This female's clutch size of five extends the previously known clutch size of 2-4 for the species (Dell and Chapman, 1977; Davidge, 1980; Bush *et al.* 1995).

ACKNOWLEDGEMENTS

We thank G. Swan for critically reviewing the manuscript.

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A RECENT RECORD OF THE THREATENED GIANT BURROWING FROG, *HELEIOPORUS AUSTRALIACUS* IN THE CUMBERLAND PLAIN OF WESTERN SYDNEY

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Heleioporus australiacus is listed as Vulnerable on Schedule 2 of the New South Wales Threatened Species Conservation Act (1996). Its recorded distribution encompasses the coast and ranges of the central coast of New South Wales, south to eastern Victoria (Cogger, 1993). The usual habitat is considered to be moist sandstone areas (e.g. Harrison, 1922; Lunney and Barker, 1986; Mahony, 1993). The species is not generally found in urban gardens or on the clay soils of the Cumberland Plain of Western Sydney (Recsei, pers. comm.), however, it is known in the area from a single specimen collected in 1913 'at Kingswood, near Penrith' (R6272, The Australian Museum).

On the 26th January 1997, an individual was located in a garden on the Cumberland Plain at Riverstone, 45 km north-west of Sydney. It was found at approximately 6 cm depth, against the foundations of a house and above a buried concrete path. The individual was collected, photographed (Figure 1) and its identity and female sex confirmed by Ms Jacquie Recsei.

On two other occasions, over an eight year period and within 220m² of this sighting, *H.australiacus* individuals have been observed. On the first occasion (early in 1989) the animal was found in a vegetable garden at approximately 10 cm depth while in March 1995 an individual was located in soil against the metal wall of an in-ground pool which was being dismantled.

All locations offered damp microhabitat in areas surrounded by hard clay soils. The nearest possible breeding site (i.e. permanent water) is a creek, where the storm water system discharges into a railway culvert. This is approximately 500 m away.

All three frongs had similar colouration: a relatively low number of yellow spots on the side and black dorsal surface instead of the more usual grey-brown (Recsei, pers. comm.).

We speculate that these animals were taking refuge from hot, dry conditions in areas of permanent moisture within the gardens.

To determine the status of the species in the area, further investigations need to be undertaken.

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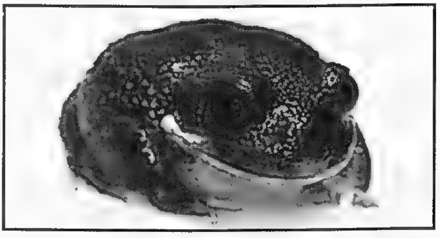
Figure 1: *Heleioporus australiacus* collected in Riverstone urban garden (Cumberland Plains, 45 km north-west of Sydney).



AN EXTENDED BREEDING SEASON OF THE ORANGE-SIDED BAR-LIPPED SKINK, *GLAPHYROMORPHUS DOUGLASI*

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The orange-sided bar-lipped skink is confined in distribution to the top end of the Northern Territory (Cogger 1992, Ehmann 1992, Horner 1992). Little is known of the reproductive seasonality of this skink. Ehmann (1992) stated females are in reproductive condition from September, through February. Horner (1992) noted that first hatchlings appear around February. Greer (1989) noted, based on a single female (SVL = 70 mm), the species is oviparous laying a clutch of at least five eggs, however no mention of seasonality was made. In a study, conducted at Northern Territory University, Myilly Point Campus in November 1996, one interesting incidental finding was the capture of three hatchling (exact age not determined) skinks of the genus *Glaphyromorphus*. These were identified, using keys of both Horner (1992; as *Sphenomorphus*) and Cogger (1992) as *Glaphyromorphus douglasi*.

G.douglasi was previously believed a subspecies of *G.isolepis* (Storr 1967; as *Sphenomorphus*), however, it is distinguishable from *G.isolepis* by colouration and having six supralabial scales, rather than seven in *G.isolepis* (Horner 1992). These features were used to positively distinguish these hatchlings as *G. douglassi*.

In this survey a total of 14 *G.douglassi* were caught by pit fall trapping. Three distinct size morphs were evident (figure 1). Four individuals, ranging in SVL from 71.9mm to 78.4mm (mean=75.4mm) were captured, seven individuals with SVL ranging from 54.3 to 63.5 (mean=58.6) and three, ranging in SVL from 26.1mm to 30.2mm (mean=28.5mm) were captured. These size classes were assumed to represent second year breeding adults, first year breeding adults and hatchlings respectively. The first hatchling was caught on November 20, the next two on November 22. Given an incubation time, in soil temperature around 30°C, for most scincid lizards is about 30 days (Greer 1989), this species must commence reproduction around mid October. Greer (1990) noted a reproductive period in the congener *G.darwiniensis* (as *Sphenomorphus darwiniensis*) of December through January. No hatchlings of any of the other *Glaphyromorphus* species (*G.isolepis* and *G.darwiniensis*) captured were found.

No hatchlings from any other skink species caught (*Carlia gracilis, C.rufilatus, C.triacantha* and *Cryptoblepharus plagiocephalis*) were caught, despite *C.plagiocephalus* being believed to be a year-round breeder (Shine 1985). Although there is little comparative data for *Glaphyromorphus, G.douglasi* appears to exhibit an early, or extended, reproductive season for a tropical Australian *Glaphyromorphus* species. In view of the paucity of information on breeding seasonality of wild tropical skinks, any further observations on reproductive seasonality will better the understanding of reproduction in tropical skinks.

ACKNOWLEDGEMENTS

Lizards were captured with permission from the Conservation Commission of the Northern Territory and the Animal Experimentatin Ethics Committee of Northern Territory University. For help collecting and identifications I thank Jane Blackwood, Patrick Gray and Keith Whitaker.

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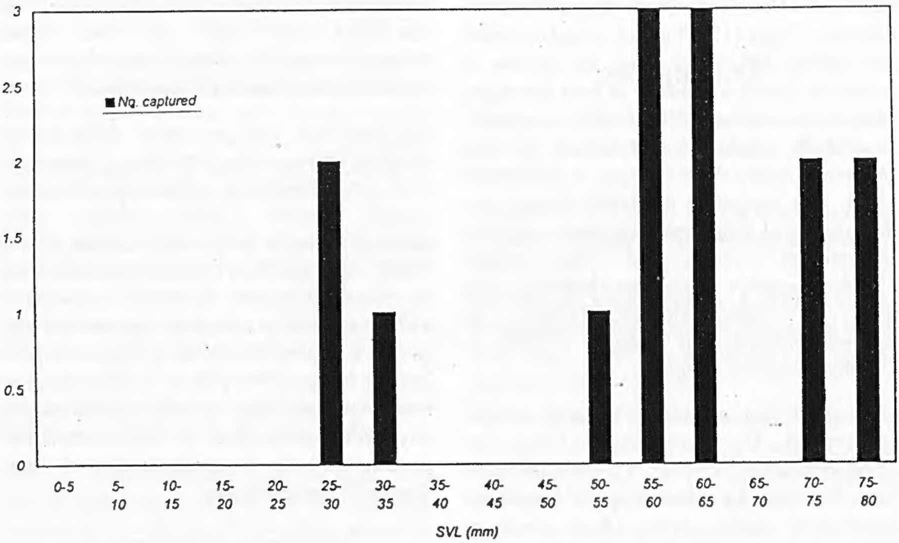
Figure 1 Size Distribution of *Glaphyromorphus douglasi*



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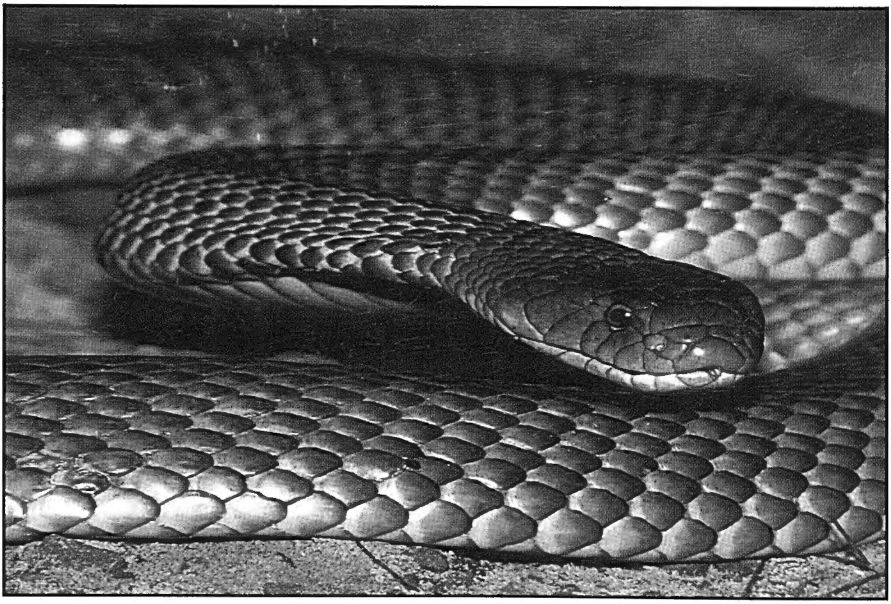
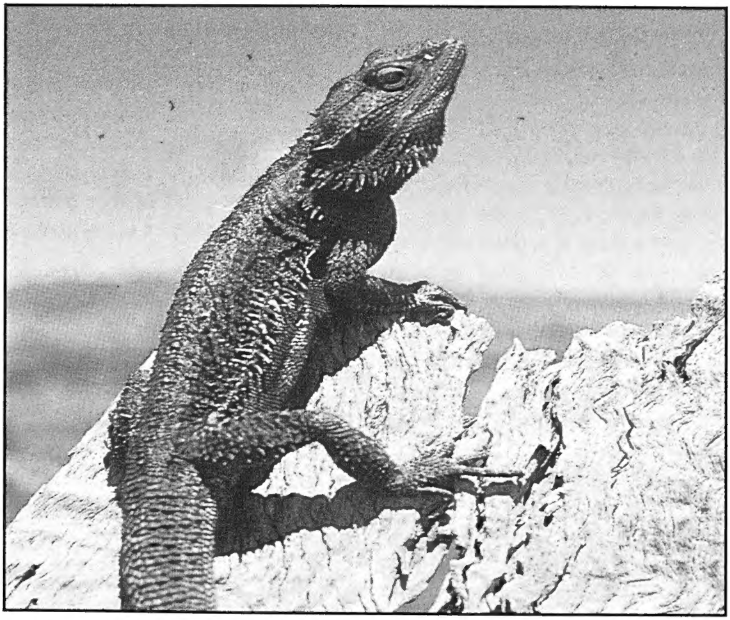


A male King Brown Snake (*Pseudechis australis*) from Sturt National Park. See paper on page 20.
(Photo: Geoff Swan)



A Central Bearded Dragon (*Pogona vitticeps*). See paper on page 28.
(Photo: Garry Daly)